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Irrigation Works in the Hawaiian Islands

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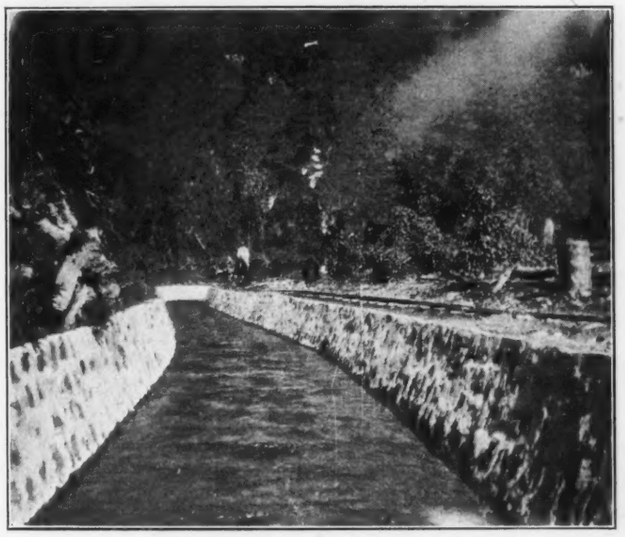
The development of irrigation projects in the Hawaiian Islands has been prosecuted with the greatest vigor by private corporations owning sugar estates during the last ten years. No aid for this work has been received from either the local Territorial Government of Hawaii or the National Government at Washington. What was formerly arid and unproductive soil, covered by wild brush and pasturing a few cattle, has been converted into productive sugar-cane land, by the application of water, at a heavy expenditure of money and enterprise.



KOOLAU DITCH.

RAINFALL.

The rainfall of the Hawaiian Islands is very local and peculiar in its distribution. The trade-winds blow off the ocean from the northeast, and on this slope a rainfall of from 60 to 200 inches per annum is quite common, the intensity varying with the altitude and local configurations, while on the lee sides the rain is often as light as from 5 to 15 inches. The islands, as a rule, are quite rugged, varying in altitude at their central highest points from 3,000 to 10,000 feet. The windward sides are covered with a dense brush, which remains green throughout the year. On the northeast slope of Maui the maximum precipitation occurs at an altitude of 1,500 feet, being often as much as 400 inches per annum at Nahiku, while at sea level and higher up the mountains it is only one-third of this quantity.

USES OF WATER.

Water is used for irrigating the sugar cane, the annual crop of sugar each year amounting to 400,000 tons, which averages $70 a ton, or $28,000,000. One-half of this is due to the development of irrigated plantations during the last twenty years. The remaining 200,000 tons are raised on rainfall plantations which are very uncertain in their output, owing to the precarious rain conditions prevailing.

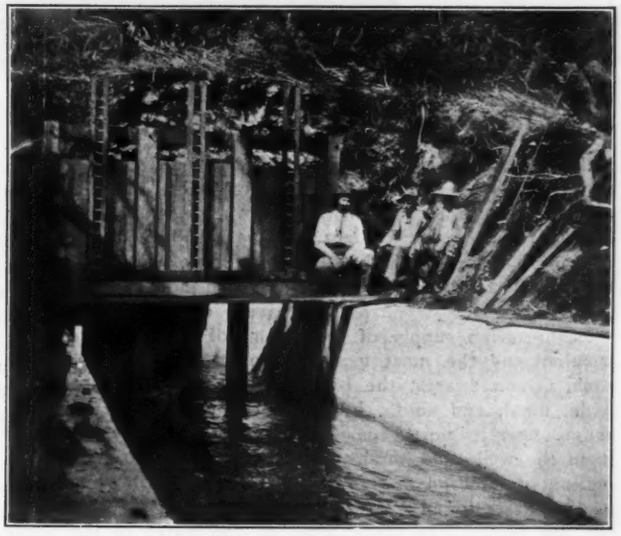
ANCIENT WATER RIGHTS.

The remains of old houses and fields bear convincing testimony that the population of Hawaii was very dense in prehistoric times. Nearly all the streams were led out by ditches çalled "auwais," and the water was used for growing "taro," the national food, and other vegetables. The ditches were excavated in surface earth and maintained by the joint users, each of whom had to devote so many days each month toward repair. The water was also distributed among its users by set rules and at stated times, each district with its branch ditch getting so many hours' flow of the stream. The land thus cultivated was always in the vicinity of the streams, as no long ancient conduits were built, and was styled "taro" land, in contrast to "kula" or dry land, which carried no water rights.

The native Hawaiians have protected, with the greatest zeal, their water rights to taro land, which the gradual growth and expansion of sugar-plantation interests have tended to absorb.

MODERN IRRIGATION.

The present water supply of the islands is derived from two sources:



REGULATING GATES.

1. By pumping ground-water or artesian waters from wells and sumps, excavated near the seashore. The pumps are driven either with coal or oil as fuel, or by electricity generated from water-power.

2. By gravity from the natural flowing streams, the impounding of the flood waters of these streams, and by the interception of ground-water by tunneling.

One of the most striking facts which the Continental engineer has to experience is the extraordinary productiveness of some of the island water-sheds, and this destroys at once many preconceived theories as to what runoffs should be. The Waihee water-shed on Maui, with an area of about four square miles, yields a daily minimum flow of 17,000,000 gallons, while the Olokele water-shed on Kauai Island, with an area of about eight square miles, yields a minimum flow of 40,000,000 gallons, and a mean flow of 70,000,000 gallons in 24 hours. Each of these watersheds is peculiarly and favorably situated for precipitation, with steep brush-covered slopes, and with almost daily rainfalls.

Nearly all the Hawaiian streams respond very quickly to rainfall, rising and falling quite rapidly, while those with a good dense brush-covered water-shed hold a volume in the streams almost constantly above a certain minimum.

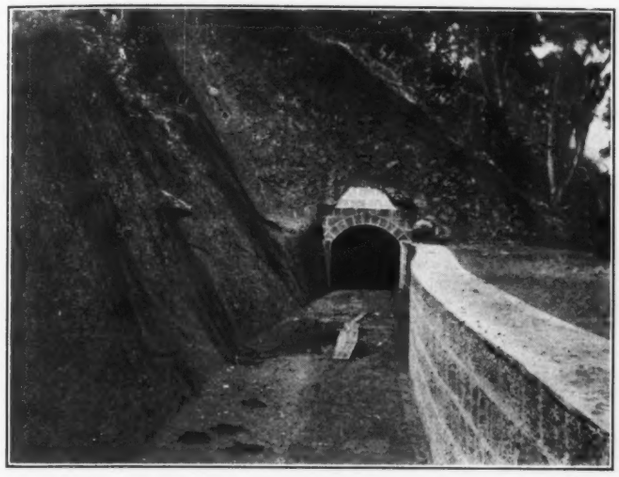
The artesian supply of the Island of Oahu is the most peculiar and the most generous found in any country of such a limited area, the island being only about 12 miles wide, north and south, by 35 miles long, with mountain ranges near its north coast 3,000 feet high. It yields daily from the wells and sumps 250,000,000 to 300,000,000 gallons without diminution of the supply, the source of which is in porous strata found at a depth of from 400 to 800 feet below the sea level. The static level of the water in the wells penetrating this formation varies from an elevation of 40 feet above the sea at Honolulu to 22 feet at Ewa Plantation, 16 miles westward. Excessive pumping or prolonged droughts vary this level somewhat, but it is always restored quickly on the cessation of the affecting conditions.

The islands are all of porous stratified lava formed in layers by successive emissions from the ancient central cones which now form the summits of the islands. The water supply in the artesian strata near the sea is sustained by mountain precipitation, and the intimate connection between the mountains and the wells is proven by the sudden discoloration of the water in the latter some hours after heavy rainfalls in the mountains.

The artesian condition of the Oahu strata is caused by a tight coral and clay cushion which rests on the foreshore and prevents the water from escaping to the sea. In none of the other islands, owing to the absence of this necessary formation, is artesian water found, the pumps being fed from sumps excavated five to eight feet below the sea level, in all of which the water level fluctuates from one to two feet, corresponding with the tidal changes, which vary in this tropical region from two to four feet between low and high waters. The depth to which it is safe to lower the static water level in Oahu wells by pumping has been tested on each plantation. The rapid increase in salt per gallon by excessive pumping, and the consequent lowering of the water level forbids extreme practice in this respect. The Oahu artesian waters carry from 8 to 20 grains of salt per gallon in normal condition, while water with salt as great as 60 grains per gallon will irrigate sugar cane successfully. The pumping stations are usually fed by a series of 12-inch wells spaced 50 feet apart and connected by a larger pipe

CROSS CUT UNDER STREAM.

with the suction ends of the pumps placed at as low a level as practicable. One million gallons have been pumped out of each well thus spaced, and 10 wells have been found sufficient for a 10,000,000-gallon pumping engine, which is the general size of unit adopted.

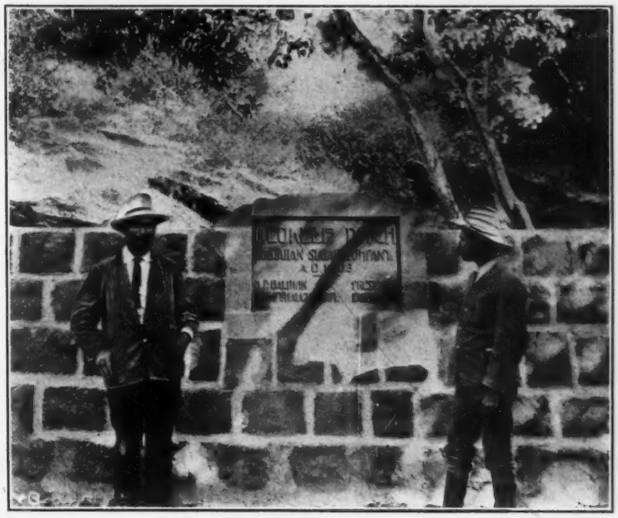


OLOKELE DITCH MASONRY.

The water is usually pumped through a 24 to 30 inch discharge pipe, varying with the size of the pump and the head. Most of the water is delivered below an elevation of 300 feet, though in a few instances lifts as high as 450 feet have been pumped against. The uncertain and fluctuating prices of sugar, the cost of fuel and other expenses practically preclude all profitable pumping above 400 feet. The work of pumping 10,000,000 gallons daily to 300 feet elevation with the ordinary pumps in service will consume 15 tons of coal, which at $8 per ton would mean $120 per day for fuel expense alone. The cost of labor, lubricants, depreciation, etc., have to be added to get the total cost. Owing to the extreme fertility of the soil as many as 8 and 12 tons of sugar per acre are raised, which yields a return of about 10 to 12 per cent on the investment. Five plantations on the Island of Oahu, namely Kahuhu, Waialua, Waianae, Ewa, Oahu and Honolulu, have a pump capacity of 287,000,000 gallons daily with a water horse-power of 11,847, and draw water from 195 wells. Waianae furnishes the novel feature of using the fall in some gravity water found in its high levels (500' to 1,400 feet) to develop power, after which the water is again used for irrigating the lands lower down, while the power is transmitted to electrically driven pumps near the sea level to lift ground-water from wells to the 150-foot level.

Maui comes next with a pump capacity of 140,000,000 gallons daily, or 6,945 horse-power, the water being drawn from sumps. Kauai has 55,000,000 gallons daily pump capacity, with 2,033 horse-power, drawing principally from sumps; while Hawaii, which is the largest of the islands, has only one pump of 7,000,000 gallons capacity, or 412 horse-power, pumping from a shaft and sump.

The steep slopes, porous soil and high elevations of the plantations have prohibited irrigation on the Island of Hawaii, which, geologically, is the most recently formed of all the islands. No flowing surface stream exists for a distance of 200 miles on the coast, from Kohala southerly around to Hilo. The soil is of such a porous nature that it passes the rainfall through like cinders, and allows no surface accumulations of water. It has the Volcanoes Mauna Loa and Kilauea intermittently active, which emit two distinct varieties of lava; "pahoehoe," which is heavy and compact, having sometimes a smooth, glassy and undulating surface, and "A. A.," which is of much less specific gravity than the former, often floating on its surface during flows and breaking up into all kinds of disintegrating masses on cooling.



OLOKELE DITCH, MAKAUCLI, KAUAI.

PARTITION WEIR.

Experience with the direct-acting, slow-moving pump of the Worthington type has not been encouraging. All new pumps now installed are of the high-speed, fly-wheel type, which consume much less coal; and, where all fuel has to be imported expensively, the greatest economy for this object has to be obtained. The pumps are nearly all installed in concrete-lined pits, 36 to 50 feet square, excavated to the water level, while the boiler plants are on the ground surface above. In three instances, at Oahu, Kihei and Kohala, the experiment of sinking shafts from the ground surface 200 to 300 feet down to the water level, and excavating pump compartments at this level has been tried. The difficulties of ventilation and the expense of the shaft and chamber have more than balanced, in each instance, the saving of cost of placing a longer delivery pipe on the surface, with its added friction loss, the elimination of which were the principal inducements for installing this system. The ground-water in such a shaft, two miles from the sea, has also been found as brackish as water found in wells 100 yards from the beach.

Outside of Oahu all pumping has to be prosecuted very cautiously, as too great a lowering of the sump level will increase the quantity of salt in the water, running it up to 100 or 200 grains per gallon, which renders it unfit for irrigation purposes, as it incrusts the soil with salt and damages the cane plants. Owing to the great porosity of the rock formation and the heavier specific gravity of the sea water, the tendency of the latter is to force itself inland where any vacuum is created by excessive pumping and consequent lowering of ground water. Annexed is a table showing the pump data regarding different plantations.

GRAVITY SUPPLIES.

All available streams are now tapped by ditches on Maui and Kauai. The first was built on the windward side of Maui in 1878 by Mr. H. P. Baldwin and Mr. S. T. Alexander. The next was built in the same section by Mr. Spreckels in 1879-80, under the supervision of Mr. H. Schussler of San Francisco as engineer. It is about 30 miles long, of 50,000,000 gallons daily capacity, delivers the water at an elevation of 250 feet, and is known as the Haiku ditch. This ditch was intercepted by a new work, called the Lowry ditch, in 1900, which delivers the water at an elevation of 450 feet. The writer has just finished a new aqueduct, known as the Koolau ditch, which taps all the Nahiku rain belt at an elevation of 1,250 feet, and discharges into the older and lower ditches. It is 10 miles long, 7½ miles being in tunnel and 2½ in open ditch and flume. The tunnels are all in solid rock, 8 feet wide and 7 feet high, with a daily capacity of 85,000,000 gallons. Owing to the extreme porosity of the lava rock, 4½ miles of concrete lining, 6 inches thick, is used in the tunnels to prevent seepage. The work was all done by Japanese with hand-drills; ore cars were used in moving the excavated materials, and its finished cost has been about $7 per lineal foot. The Japanese make excellent miners and rock men, and, owing to their small size, it was practicable to work four in a face, and by working three eight-hour shifts, the whole work has been completed in eighteen months from the date of commencement, April, 1903. There are 38 tunnels, each averaging 1,000 feet long, the shortest being 300 feet and the longest 2,710 feet. The country was so steep and precipitous that little ditching could be used, and it was necessary to make 4½ miles of wagon road and 18 miles of stone-paved pack trails to facilitate, during construction, the transportation of supplies. About 7,000 barrels of cement and 240,000 pounds of giant powder were used. In all, ten mountain streams are intercepted, which are admitted into the main aqueduct through screens of grizzly bars, spaced three-fourths of an inch apart.

PACK TRAIN.

The Honokahau ditch—with 30,000,000 gallons daily capacity—has just been finished on West Maui. It is 13½ miles long and on a grade of five feet per mile, and has 2,000 feet of 36-inch siphon pipes and 3½ miles of tunneling, and has cost $185,000. It delivers water at an elevation of 700 feet.

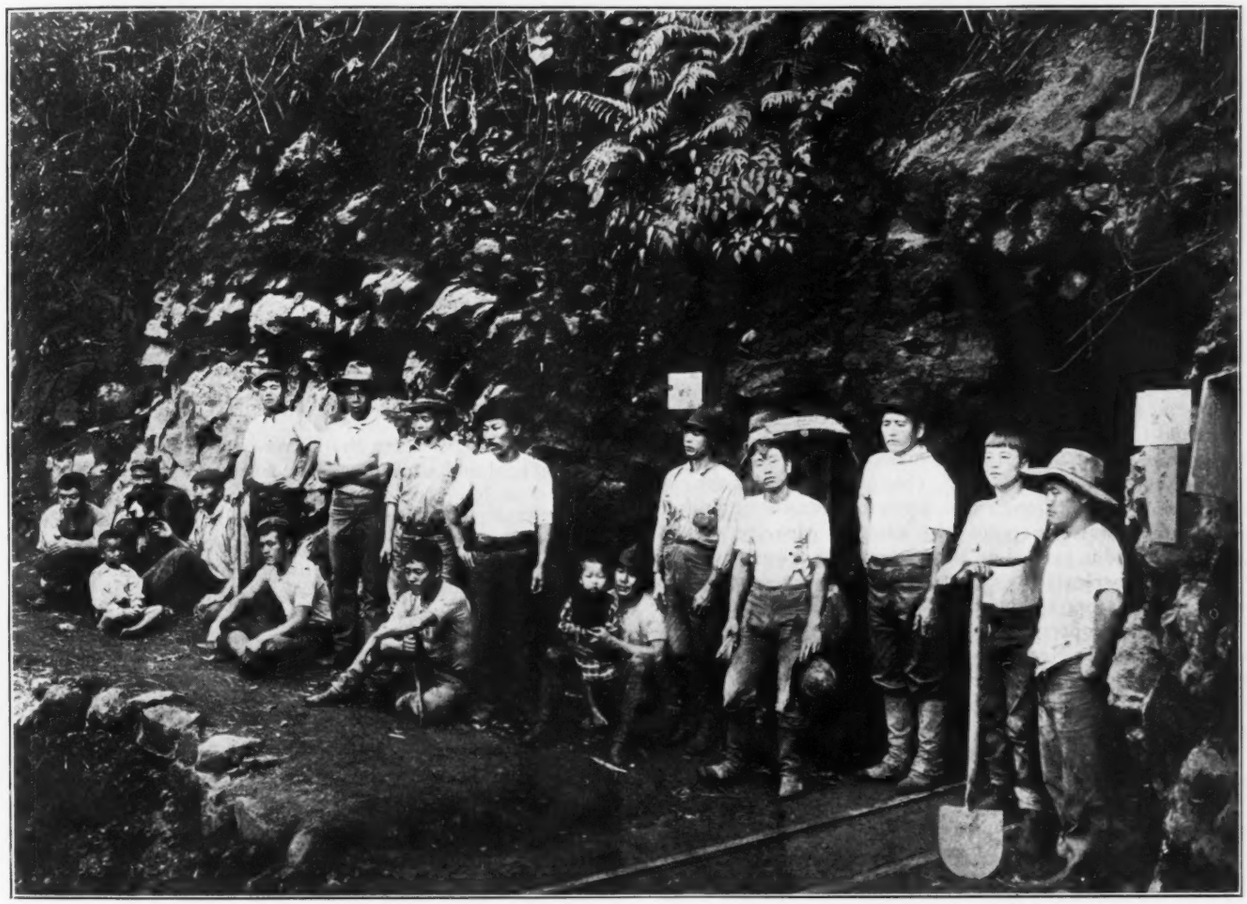
All streams on the Island of Maui, including the Waihee stream at Wailuku, are now tapped by the ditches previously referred to.

The Hanapepe ditch, Makaweli, Kauai, was built by Mr. Baldwin in 1890 to tap the stream of that name. It has 7,040 feet of 40-inch riveted steel siphon pipe, 1,013 feet of tunnels, 14,618 feet of flume, 5 feet wide by 40 inches deep, and 10 miles of ditching on a general grade of 6 feet per mile, and carries 35,000,000 gallons daily. The use of wooden flumes

in tropical countries is not advisable, as repairs have to be made frequently, owing to the rapid decay of the wood. This ditch delivers water on the plantation at 450 feet elevation, and a new one, just built and completed under the writer's supervision, known as the Olokele ditch, delivers water at an altitude of 1,075 feet and has a daily capacity of more than 60,000,000 gallons. It involves 8 miles of 7 by 7-foot tunnels, 5 miles of ditching, and it has cost completed about $360,000. At one point a drop of 228 feet was obtained, which it is proposed to utilize for electric power purposes in operating the plantation mill and railway. Makaweli Plantation now has the best gravity supply on the islands, with a daily minimum, from its two sources, of 65,000,000 gallons. It is proposed, later on, to store the freshet waters in reservoirs, and to use them as balancing mediums to restore the supply when the streams run low. Owing to the steep land slopes, 6 to 15 degrees, it is very difficult to select favorable reservoir sites, except in the center or back of old volcanic cones.

Many streams have been diverted and reservoirs made during the last five years on the Wailuku and Pioneer Plantations on Maui, the Oahu and Waialua Plantations on Oahu, and the Koloa, Makee and McBryde Plantations on Kauai; but, for the reasons before stated, practically no stream diversion for irrigation has been made on the largest island, Hawaii, except the Kohala ditch completed this year by the writer

(To be Continued)



JAPANESE TUNNELMEN.

OPENING OF THE POWER PLANT ON KAUAI.

The new electric plant of the Kauai Electric Company at Wainiha, Kauai, was formally put in operation on August 4, 1906. At that time the promoters of this enterprise extended —through Mr. A. Gartley—a limited number of invitations to the representative business men of Honolulu to visit and inspect the plant. The Inter-Island Steam Navigation Company's steamer "Mauna Loa" conveyed the party to Waiuha. After most elaborate ceremonies, the party returned to the steamer and proceeded along the west coast of Kauai, between Kauai and Niihau, running close inshore to give the passengers an opportunity to view what is considered the most magnificent scenery in the Hawaiian Islands. This section of Kauai is known as Na Pali and derives its name from the fact that towering Palais rise fully 3,000 feet from the water's edge. This country is inacessible except on the oceanside, and the fact that steamers seldom go around this end of the island makes this trip of special interest.

The palis are cut with the deep valleys of Hanakapiai, Hanakoa, Kalalau, Milolii and Nualolo, all of which are inaccessible except by rugged mountain trails. The steamer then passed Mana, Kekaha, Waimea and Makaweli and the passengers were landed at Hanapepe bay at the Eleele landing. The plantation railroad of the McBryde Sugar Company was then pressed into service to carry the passengers to visit the pumps in the Hanapepe Valley, the mill of the McBryde Sugar Company and through the cane fields to the beach home of the McBrydes at Lawai. Here an opportunity was given for taking a plunge in the surf, which is said by many to be the finest in the Hawaiian Islands.

A luau was served in the large cocoanut grove surrounding the house. Mr. Walter McBryde gave this luau his personal attention.

A moonlight trip to Koloa ended the day. The party then returned to Honolulu.

The installation of the Kauai Electric Company is the first large high-voltage transmission plant in the islands. A small plant has been installed at Waimanalo and another one at Lahaina, while the Territorial Government has a small plant in Nuuanu Valley, and the Hilo Electric Light Company's plant is operated by water power. These are small in comparison with the Kauai Electric Company's plant.

The urgent necessity of reducing the cost of power for pumping on the McBryde Plantation led W. A. Kinney and the stockholders of McBryde plantation to investigations which resulted in the selection of Wainiha Valley for this large water power development.

This is perhaps the deepest and largest valley in the Hawaiian Islands, as it extends from the beach to fully 15 miles inland, cutting out a deep gorge to the very heart of Waialeale. Fully seven miles from the beach the palis on each side of the valley are 4,500 feet high.

A large rainfall gives a permanent water supply of about 60,000,000 gallons per day. To make use of this water was the problem presented to the engineers engaged to do this work. Surveys were made by W. E. Rowell and J. M. Lydgate and operations commenced. Ditches and tunnels having an aggregate length of five miles bring the water to a point 575 feet above the power-house. It is then carried down through two 30-inch pipes to operate the electric machinery below. These machines are 3-phase, alternating current generators mounted on a shaft between two bearings, and on each end of the shaft there is a large water-wheel of the Pelton type. The generators are 1,200 kilowatt capacity and generate current at 2,200 volts. This current passes through a switchboard and through two banks of transformers, there being three transformers of 500 kilowatt capacity in each 33,000 volts and is carried on three aluminum wires supported bank. The current leaves the transformers at a voltage of on large insulators to the transformer station in Hanapepe Valley, on the property of the McBryde Sugar Company, a distance of 35 miles. Here the current is stepped down through three 875 kilowatt transformers to 2,200 volt and then through a switchboard for distribution to the motors running the different pumps.

At the present time there is one 500 horsepower motor installed, attached to a two-stage centrifugal pump, built by the Buffalo Steam Pump Company, and one 150 horse-power motor attached to a two-stage centrifugal pump, built by the Byron Jackson Company. Two 50 horse-power units are being installed in the new pumping station No. 2 and a 1,000 horse-power motor and pump is to be installed at No. 3 pumping station and a 350 horse-power motor and pump in Lawai Valley.

When these pumping stations are complete and in operation McBryde will have over 15,000,000 gallons of additional water available for use on her fields. The horse-power available on McBryde for this plant will be 2,600 horse-power and the operating expense of the entire plant will only be from one-fourth to one-third of the present expense.

McBryde may be considered the pioneer in pumping water on cane fields with large electric units, and there is probably no industry west of the Rocky Mountains employing as many large motors as will have been installed for this enterprise. Unquestionably several installations of this kind will be promoted within the next few years.

The entire installation has been accomplished by island firms. Henry Jaeger has completed the ditches and tunnels, the Honolulu Iron Works the pipe lines and the Hawaiian Electric Company have been both the contracting and consulting electrical engineers. They have made the complete installation of the power plant, pole line, transformer station and the motors on the McBryde Plantation.

THE SMOKELESS CITY

The problem of abating the smoke evil in our cities is one that comes up constantly. The "American Contractor" has recently emphasized the importance of the gas engine as a factor in eliminating this evil. There seems to be no question but that the gas engine is the most economical medium for converting coal into power that has ever been devised. Long distinctly recognized, this fact has been recently reduced to a demonstration by exhaustive experiments conducted by the United States Geological Survey. With this as a starting point there seems to be no great difficulty in arriving at smokeless cities. By this plan the fuel of a city, and that for all purposes, where bituminous coal is employed, can be generated at convenient stations, far enough beyond the city limits, and piped into the town, thence to be universally distributed. Thus all the power required in a city can be developed without producing a single puff of smoke, and that at a decided saving of money and annoyance. More than that, fuel gas for heating can thus, in a wholesale way, be furnished at a lower price than the coal from which it is made. Thus will smoke be entirely dispensed with, the resulting coke providing a smokeless fuel where direct combustion is for any reason desirable or necessary.

O n the subject of the burning of coal and the effects of the same in vitiating the atmosphere of cities, the work of a recent statistician is of decided value. He finds that in the metropolis the average amount of coal burned in a year per capita is 3.12 tons, whereas Boston burns 6.70 and certain western cities 8 or more. On the other hand, for every one of her 4,000,000 residents New York uses 8,000 cubic feet of gas a year, whereas other large cities consume from 3,000 to 6,000 feet only.

Since the days when the steam engine was first brought into practical and widespread use, heat and power have been regarded as interchangeable, and this has been greatly emphasized by the introduction of the dynamo, which makes "the rule work both ways." There is no good reason why our modern cities cannot be entirely relieved from the smoke nuisance. This can be done by simply interdicting the sale of soft coal as a direct fuel.

PROPOSED ELECTRIFICATION OF LOCAL ROADS OF THE SOUTHERN PACIFIC CO.

General Manager E. E. Calvin of the Southern Pacific Company has announced that the two steam roads running from Alameda and Oakland to the Alameda Mole are to be converted into electric roads. The plans are already completed, and the work of reconstruction will be begun as soon as the necessary material can be obtained. The cars are to be of the overhead trolley type and will each have a seating capacity of eighty-four. The plans include the erection of a large power-house at Alameda Point, near the present location of the roundhouse. One million one hundred and twenty-six thousand seven hundred dollars have been voted for these improvements.

The Southern Pacific Company is also planning to change to electric traction the Encinal Avenue line and the Lincoln Avenue line, which also run through Alameda. The latter is to continue on to Melrose over the greater part of the local line which crosses the Fruitvile Avenue bridge.

INCANDESCENT LAMPS.

Herr Teichmuller collects the following as being the consumption of electrical energy by the different electrical incandescent lamps now in current use: Carbon filaments 3.2 and 3.5 watts per Hefner candle (=3.65 to 3.99 watts per British standard candle); tantalum lamps, 1.76; osmium lamp, 1.5; zirconium-carbon, 2.44; zirconium lamp, 1; and the new "metal-filament" may possibly bring this down to 0.5.—The Gas World.

SUCCESSFUL MUNICIPAL CONTROL OF AN ELECTRICAL PLANT IN NEW ZEALAND.

The problem of municipal control of public service systems has aroused a great deal of interest, both for and against, in the past few years throughout this country, and the results of operation of a small plant in Christchurch, New Zealand, will be of interest.

The city refuse was destroyed by the plant, thus furnishing fuel for the generation of the electric power, and extracts from the balance sheet furnish the basis for the following report for year ending March 31, 1906, issued by Lawrence Birks, B. Sc., A. M. I. C. E., consulting electrical engineer:

The results of operation as shown in the Electrical Maintenance Account, are as follows:

Expenditure.

Revenue.

Balance from 1905	£ 280	3	3
Sale of Current for Light	3,685	15	10
Sale of Current for Power	2,020	8	8
	£5,986	7	9
Salaries and Wages	£ 950	9	1
Stokers' Wages	1,011	8	8
Coal	1,200	5	8
Oil Waste and Stores	217	6	8
Repairs	54	8	10
Office Expenses	35	15	3
Interest	583	9	8
Depreciation (paid off Capital Account)	1,933	2	11
	£5,986	7	9

The capital expenditure on the plant on March 31, 1905, was £17,476 5s. 6d. Additional capital expenditure for the year amounted to £3,764 18s. 8d., making the total capital outlay at the end of the year £21,241 4s. 2d., and the average capital for the year, £19,858 14s. 10d. On this capital the above returns work out as follows:

Interest	3 per cent.
Depreciation	9¾ per cent.
Total working profit	12¾ per cent.

It must also be noticed that the operating expenses include an item of £1,011 8s. 3d. (i. e., 5 per cent of the capital) for "stokers' wages," the whole of which would be spent, in any case, in the destruction of the refuse, but as this is now one of the operations involved in the generation of electricity, it is charged in full against the electrical maintenance account. At the same time, no credit is taken in the accounts for the refuse destroyed.

In the face of the very keen competition of the gas company, these are very good results indeed for the third year of operations.

The general results of the Council's electrical plant have thus been that it has paid its own way and relieved the city of the cost of destroying the refuse, and paid interest and 3¾ per cent depreciation in the second year of operations and interest and 9¾ per cent depreciation in the third year; it has brought about by its competition a reduction in the charge for gas from 6/3 to 5/9 net per 1,000 cubic feet, thus benefitting practically all the ratepayers; it has supplied in many houses and factories a keenly-felt need for a convenient, clean, silent, harmless, and odorless source of light and power; and has demonstrated the market and thus brought to a head the question of the supply of electrical power on the large scale from the water powers of the Western Alps.

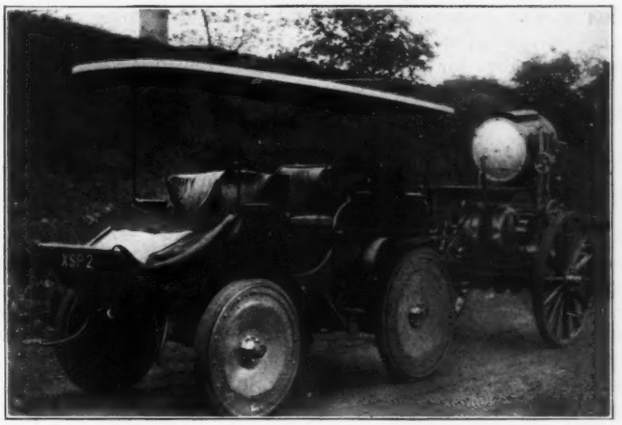
Present plant capacity.....350 kilowatts

Present charges....2¼d. per unit for power, 6d. to 3½d. per .....unit for light

THE AUTO-CAR WITH ELECTRIC GENERATOR AND SEARCH LIGHT.

The power available on the automobile, auto-car and traction engine is now utilized extensively for operating electrical dynamos for lighting service, as portable electric plants, and are very useful for fire department service, with search lights, for army service and for construction work where electric lights are desirable.

The accompanying illustration shows an English auto-car equipped with a 3-cylinder engine having a capacity of 20 horse-power which is fitted with a pulley as seen just above the rear wheel for belting to an electric generator mounted on a trailer cart.



This view shows the Sirdar's car which is operated by an internal combustion engine using paraffin as a fuel, petrol or gasoline only being used for starting purposes. It is provided with a clutch so attached to the engine that the dynamo may be driven when the care is standing, current being supplied to a search light which is also mounted on the trailer as noted in the illustration at the right. It will be noted that dished wheels are provided which are suitable for use on the sand of the desert, and a special tank is also installed on the car for storing fresh water for drinking purposes. This supply can also be used for cooling the engine if it is found necessary.

The electric searchlight can be raised or lowered or turned on its mounting on the trailer as desired, and the current can also be used for incandescent electric lighting if it is wanted. It will be noted that disc wheels of solid construction are used and the car is capable of carrying from six to ten persons comfortably.

An outfit of this kind would be particularly desirable for military service providing electric lghts n camp, searchlight service when required, and means for rapid transportation of men and materials. The Sirdar's car was built at Paisley, England, by The New Arrol-Johnson Car Co., Ltd., well known as celebrated British Builders of Commercial Motor Cars.

Steam and gasoline traction engines are also constructed in Great Britain, equipped with electric plants, in some cases the same engine which drives the car being utilized for driving the dynamo, in a similar manner to that above described, but the dynamo being mounted on the same car; while in other cases a separate engine is employed directly coupled to the electrical generator and taking the steam from the same boiler as the traction engine. The English designed "Savage Tractor" has been equipped with a direct connected electric plant, and it operates independently of the traction engine. The Savage Tractor has heavy wooden wheels and has a normal speed of five miles per hour.

This type of auto-car or tractor is of great value also for military service and can be utilized by contractors to advantage for illuminating their work while pushing the construction with gangs of men working both night. and day.

COMPARATIVE COST OF MAINTAINING STEAM LOCOMOTIVES AND ELECTRIC EQUIPMENT.*

One of the problems which must receive due consideration in connection with a change from steam locomotives to electric equipment is that of the cost of maintenance, and this problem has been the subject of more or less discussion in clubs of this nature. At a recent meeting of the New York Railroad Club a comparison was made between the equipment at terminals necessary for handling electric and steam locomotive equipment, in which the impression was given that the former required a greater amount than the latter. An investigation of the subject will hardly bear this out as one of the heaviest items of expense incident to the maintenance of steam railroads during the past few years has been the extension to and construction of repair shops, and some of our large steam railroads now have several million dollars invested in shops for making repairs to locomotives alone. An investigation of the electric lines will show that no such investment is necessary for the maintenance of this equipment. For instance, at the terminal of the underground system of the Interboro Railway in New York we find a repair shop of very small dimensions, containing a very few machine tools, all of light capacity, and giving employment to probably forty or fifty men. In this little shop all of the repairs are made to an equipment of 430 motor cars each equipped with two 200-horsepower motors, or a total equipment representing 172,000 horsepower in 860 motors. This would be equivalent to 215 steam locomotives of 800 horsepower each. It will be found that a steam railroad having in the neighborhood of 200 locomotives to keep in repair has shops covering many times the area of those of the Interboro and containing equipment of tools and machinery much more extensive and giving employment to five or six times as many men; and in addition, several round-houses, any one of which represents a greater investment than the entire Interboro shops. This, however, does not begin to represent the total difference between the cost of maintaining steam locomotives and electric equipment.

The average terminal charge for cinder pits, turntables, inspection, etc., is about $1.50 per locomotive which enters the terminal, while the corresponding cost per motor car is only from 20 to 25 cents. Assuming that three motor cars are equivalent to one locomotive, this gives a terminal charge of 65 cents for motor car equipment against $1.50 for steam locomotives.

The average cost of maintaining steam locomotives has for some years past, owing to the great increase in the weight of these machines, increased to figures which are somewhat startling. On one of the largest railways of this country the cost per locomotive per year for 1904 was $3,772.00; for 1905, $4,165.00. On another road the cost for 1905 was $3,473.00 per locomotive. On another, $3.565.00. These, however, are exceptionally high figures, as on some roads the cost has been as low as $1,200.00 to $1,500.00. On thirteen of the largest railways the average cost of 7,228 locomotives for 1904 was $2,212.00. The average cost per year for maintaining an aggregate of 7,684 motor cars, making an aggregate of 157,059,486 car miles, was only $107.00 per motor car per year. The average for maintaining the steam plant, electric plant and cars, including electric equipment, on these roads, was only $255.00 per car per year, or about one-eighth of the cost of maintenance per locomotive per year on the thirteen steam roads referred to.

It is only reasonable to suppose that the cost of maintaining electric motors on roads such as are now being operated by steam locomotives will be much less than the cost of maintaining motor cars on street railways, as the amount of dust and dirt to which they will be subjected will be very much less.

A comparison of the number of parts subjected to constant wear on steam locomotives and the electric equipment shows that it would be only reasonable to suppose that the cost of maintenance will be very much less on the latter. The parts of steam locomotives subject to constant wear during service are as follows:

1. Cylinders.
2. Guides.
3. Cross Heads.
4. Crank Pins.
5. Links and Blocks.
6. Valves.
7. Valve Rods.
8. Rocker Arms.
9. Rocker Shaft.
10. Pistons.
11. Piston Rods.
12. Piston Rod Packing.
13. Valve Rod Packing.
14. Reverse Lever.
15. Throttle.
16. Throttle Packing.
17. Truck Axle Bearing.

The parts of electric equipment subject to constant wear are motor bearings, brushes, commutators and trolley. With motor cars gears should be added to this list, and with electric locomotives having forced ventilation the ventilating fan and fan-motor should be added. The wear of brushes is a small item, as the tests made with the New Haven locomotive show that one set will run 12,000 or 15,000 miles, which will represent from two to three months' service.

It might be argued that controller fingers and unit switch fingers should be added to this list, but the wear on these parts is small. Controller fingers with multiple switch control are subjected to only fourteen volts and seldom give out. The multiple unit switch fingers have been subjected to most severe tests, and several of them have broken the current to which they are subjected in service one hundred thousand times without being worn out.

Portions of the electric equipment are, of course, liable to be burned out, owing to short-circuit or abuse, but the liability of such failure is not greater, if as great, as that of burning a crown sheet or flues in a steam locomotive boiler owing to low water, and the results are not nearly so disastrous, as they are never accompanied by a loss of life, and seldom by the laying down of the train. If a flue blows out or the crown sheet goes down in a locomotive, it must abandon its train and be hauled home dead, if it has not been derailed, while if a motor is burned out, this motor can be cut out and the car or locomotive can take its train home without difficulty.

*Extract from a paper read before the New England Railroad Club, by Clement F. Street.

SCARCITY OF FUEL FOR SUCTION GAS PLANTS IN ENGLAND.

The recent successful development of suction gas plants using anthracite coal has led to such a great demand for the particular sizes of that coal known as "peas" and "beans"—for the use of which these gas plants have been more especially developed—as to cause the prices to rise considerably.

"Peas" and "beans" were, until this development of the gas engine plant, the forms of anthracite for which there was not so great a demand; this naturally encouraged manufacturers and inventors to develop apparatus capable of utilizing these sizes of anthracite coal in preference to any other.

Anthracite coal has always sold at a good price, and the demand for a variety of special purposes such as malting, stoves, etc., is now rapidly increasing; this naturally forces up the prices, so that the outlook for the owners of suction gas producer plants designed for this fuel is anything but hopeful as regards the possibilities of cheap power.

All the anthracite collieries are about as fully developed as they can be, and it requires a large output to produce even a few trucks per day of the smaller sizes such as "beans," while the cost of production also keeps creeping up; so prices are likely to remain firm for some time, as the demand seems to have overtaken the supply.

Recently fancy prices have been paid by the owners of those plants which had run short of coal, and who had, therefore, to obtain it at any price or shut down.

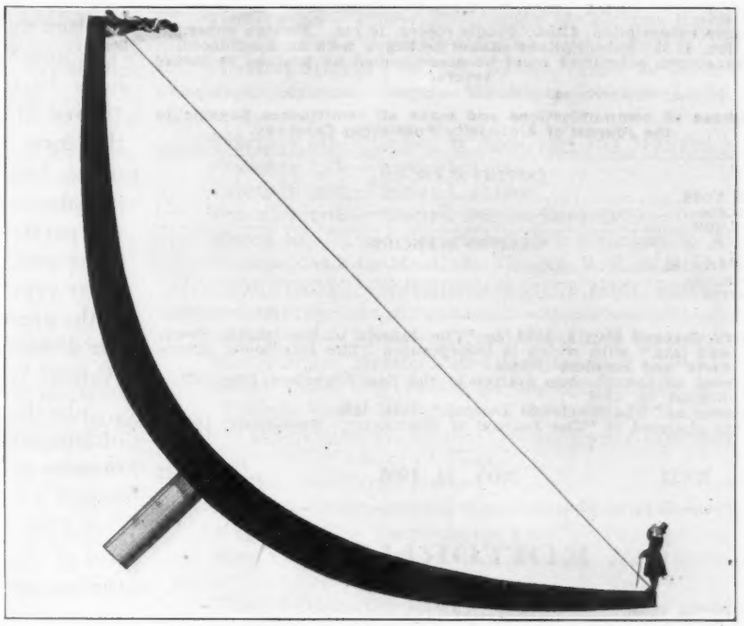
THE MAGIC SPHERE OF SIR HIRAM MAXIM.

In the accompanying illustrations, Figs. 1-2, may be seen the magic sphere, a scientific novelty, for public amusement. Sir. Hiram Maxim, the American inventor of the Maxim gun and airship enthusiast, who is now residing in London, England, designed the electric magic sphere which consists of a revolving floor or stage parabolic in form and so arranged that the centrifugal force operating in conjunction with the shape of the floor makes it appear to everyone standing on the same that they are standing on the only part of the floor that is level while all of the rest of the floor seems to be tilted up.

Steam, gasoline engines or electric motors may be utilized for rotating the parabolic floor at such a speed that the centrifugal force about equals the attraction of gravitation. It is easy for a person to walk about the circumference, but difficult when the floor is under motion to walk diametrically. Those entering the magic sphere and standing on the outer edge imagine that they alone are on the level, while those persons on the opposite side of the parabolic floor appear to be walking on a vertical surface. Each one considers himself extremely heavy while the others seem to be very light, and when moving across the floor the entire apparatus seems to be rolling over him like a ball floating on the water. In the case of bicycle riders riding around the circumference, they appear to be riding on a vertical surface, as noted in Figs. 1 and 2.

In order that every part of the rotating floor should appear level to those standing on it he so constructed the curved surface that the centrifugal force and the face of gravity exactly balance each other. This required a proper parabolic curve. The parabolic floor is 30 feet in diameter and makes about 15 turns per minute, while it will be noted that the extreme outer edge of the sphere is above the horizontal about 45 degrees.

When such a floor is revolved in a room, which was stationary, it has the same effect that a person feels when turning around very rapidly on one heel or on skates, and dizziness would result in the same manner as if one were standing still and the room revolving about him. But by rotating the parabolic floor on which the observer stands and the sphere or room over him at the same time, he does not become dizzy.



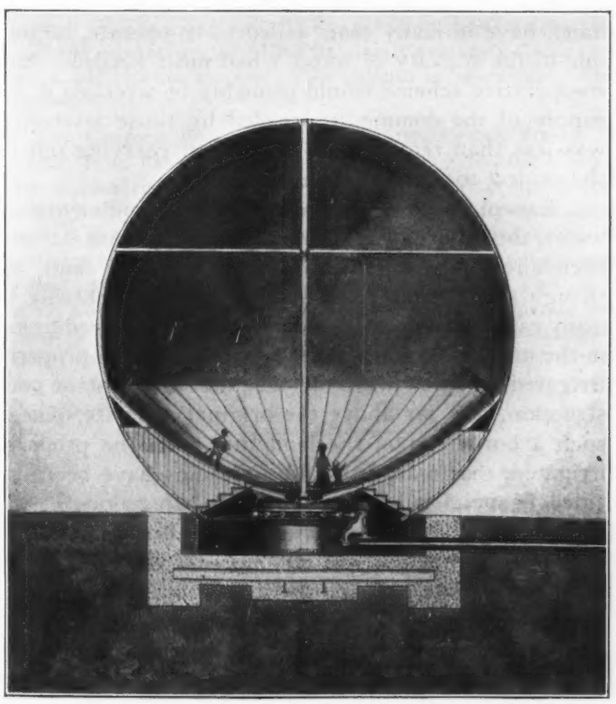
THE REVOLVING FLOOR OR STAGE.

The electric magic sphere is decorated like a terrestrial globe on the outside with proper map and the observers enter the same at the bottom at the center. The accompanying illustration shows a vertical central section of the Maxim magic sphere with the necessary driving gear and the telescope on which the sphere is mounted, as well as the stairway.

This illusion apparatus is said to be particularly well adapted for a skating rink and most curious optical results are produced on the central part. It is stated that when mounted on roller skates some most extraordinary feats are performed with slight effort and the marvelous performances appear most striking to the observer.

In the case of a skating rink the parabolic floor is much larger and flatter and the speed of rotation would be considerably slower. There is every reason to believe that the magic sphere will become most popular at the sea side resorts.

Electric power is found to be most desirable for operating the magic sphere as the motors can be located at the base and directly geared to the sphere while the control may easily be accomplished from an attendant on the parabolic floor within, or handled from the ticket office if found desirable.



THE ELECTRIC MAGIC SPHERE.

The proposal to transmit electricity generated at the Victoria Falls to Pretoria and Johannesburg is taking shape, and a first issue of capital will, it is said be announced within the next few weeks. The distance from the Falls to the Rand as the crow flies is 600 miles, but it will be necessary to make deviations that will increase the distance to be covered to nearly 700 miles. The extraordinary pressure of 150,000 volts is proposed. At the outset provision is to be made for 30,000 horsepower, but this may be increased as necessity arises.

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EDITORIAL.

MODERN IRRIGATION SYSTEMS

Closely allied to the construction of water power electric transmission systems is the hydraulic development connected with the building of the dams, head gates and water conduits of irrigation plants such as are being built in many localities in the arid portions of the western part of the United States, these irrigation systems being constructed both by the government and by private interests. The extensive construction work of the irrigation systems in the Hawaiian Islands, as described in the article we published this week by Mr. O'Shanghnessy, has practically resulted in the redemption of all of the lands, to irrigate which, the systems were built. The peculiar climatic and geological conditions in Hawaii make the systems there constructed somewhat different than those built on the Pacific Coast, but engineers and others interested in the building of water conduits for any purpose will find in this article a large amount of data not heretofore published. As the directing engineer of the entire work, Mr. O'Shaughnessy on the one hand had almost unknown engineering difficulties to overcome, and on the other was given exceptional opportunities to determine not only the best form of construction, but by keeping accurate records, was able to accurately determine the cost of such work. The detailed data which he gives will be found to be not only thoroughly reliable, but is presented in such a form as to be most readily utilized in estimating the cost of similar work.

Up to the present time not enough irrigation work has been completed by the Government Reclamation Service to give thoroughly reliable data. An enormous amount of information has been compiled and published by the government engineers, but in most cases such data is not backed up by the experience and information obtained from the actual installation. Particularly is this the case regarding the cost of construction. The details of the work done in building each system so modify the cost of construction that it is often difficult to apply the data to other installations. The number of open water conduits or ditches which have been lined with cement are not great in the United States. Southern California, perhaps, has used this form of construction to a greater extent than any other locality. All of this work has been done by private interests, and it is a difficult matter to obtain comparative costs from these installations For the most part, they are small, and the work completed many years ago. For comparison with work to be done at the present time the information to be obtained from the investigation of the Southern California irrigation systems is not particularly satisfactory.

In the public mind, the construction and operation of irrigation plants have not been successful. Many reasons are advanced for the financial difficulties into which a great number of irrigation companies have found themselves. It is generally thought that the control of the construction of such irrigation systems by the government will change these failures into successful enterprises. One reason for the failure of many irrigation systems has been an overestimation of the quantity of water available, particularly during the driest seasons. Adequate water storage in arid regions is always expensive, and in almost every case, in as much as the irrigation work is carried on principally during the driest seasons, large storage reservoirs are necessary. The individual users of water, on the other hand, have in many cases failed to co-operate, largely due to the scarcity of water when most needed. Any co-operative scheme would probably be wrecked if the supply of the commodity needed by those interested was less than required for the proper carrying out of the project to a financial success.

Except in the one particular of insufficiency of water, the failure of private irrigation schemes has not been due to the engineering work being at fault, although the cost of the installation has undoubtedly in many cases been grossly underestimated. The reduction in the number of acres of land which could be properly irrigated, coupled with the fact that the cost of construction, was far above the original estimate, placed such a burden upon the land that could be properly irrigated, that many irrigation systems have been decided financial failures. The work being done at the present time by the government and also by a number of private companies will undoubtedly place irrigation in a much more satisfactory light, both financial and otherwise. Where a single company controls the land as was the case in Hawaii, and the engineering work is carried out as it should be, the results have been extraordinarily satisfactory.

THE CALIFORNIA JOURNAL OF TECHNOLOGY.

The November number of "The Califonia Journal of Technology," which is published by students of the applied science colleges of the University of California, contains a lengthy article on "The Design of a Railway Bridge Pier" by Professor Charles Derleth of the faculty of the College of Civil Engineering. Professor Derleth's article is very complete, including a discussion of underlying principles, details of design and working drawings, and an estimate of costs. Some of the other contributions are: "Remarks on Some Fluid Apparatus," by John Richards, the well known San Francisco expert on hydraulic machinery; "The Stassfurt Salt Industry," by Professor W. C. Blasdale; and shorter articles by Lewis A. McArthur, Elbert M. Chandler and Kent A. Hawley.

The student management of this magazine met with considerable difficulty in reorganizing after the April fire, but the excellent character of this issue shows that their efforts have not been in vain.

TRADE CATALOGUES.

The Allis-Chalmers Co. is sending out a complete index of the many publications which have been issuued from time to time to properly advertise the numerous kinds of machinery which this company manufactures. The catalogues, bulletins, leaflets, books of instructions and other publications, all of which are kept well up to date, are classified first according to their respective numbers, and then according to the subject matter dealt with, thus making a valuable reference list for those desiring literature on some particular class of electrical, mining, pumping, flour or saw mill or other machinery. It may be interesting to note that about eighty publications averaging twenty-four pages each, were issued during the past sixteen months, representing about 80 per cent of the products manufactured by this company.

Bulletin No. 1417, recently issued by the Allis-Chalmers Company, deals with Smelting Furnaces and Acessory Equipment. Forty-six pages are devoted to lead and copper furnaces, blast stoves, steel water jackets, forehearths, slag pots, cars, barrows, and other furnace accessories, besides horizontal blowers, either belt-driven, or direct connected to electric motors or steam engines. The concluding pages briefly suggest the advantages of Allis-Chalmers Company's Corliss engines and electric motors. This bulletin is handsomely illustrated.

The Century Electric Co., 404 North Fourth Street, St. Louis, Mo., has devoted its Bulletin No. 7 to single phase alternating current motors of both the constant speed type and the variable speed type. A feature of the constant speed motors is that they are self-starting under full load, requiring nothing more to start them than the closing of an ordinary switch placed anywhere in the supply circuit. This is a great advantage where it is more convenient to operate machinery from distant points. The standard types are designed to be used interchangabiy on either a 104 or 208 volt circuit for rated full load capacities ranging from one-quarter to five horsepower.

PERSONAL.

Mr. C. M. Wood, general manager of the Century Klein Electric Co., after an extended trip East, of two months, visiting all the principal cities of the United States, has just returned to San Francisco and reports having added to their already large list of number of new agencies, covering all lines of electrical supplies and equipment.

Mr. Edward Warren Currier is now connected with the electrical department of Fairbanks, Morse & Co., at Los Angeles.

UNIVERSITY OF WASHINGTON

The department of electrical engineering of the University of Washington announce a course of special lectures during 1906 and 1907, as follows:

"Electric Traction," by Mr. Elbert G. Allen, M. S. (Mass. Inst. of Tech.), chief electrical engineer, Seattle Electric Co.

December 5th—"Traction Dynamics."

December 12th—"Train Movement."

December 19th—"Generating and Sub-Stations for Electric Railways."

January 9th—"Power Distribution for Electric Railways."

January 16th—"Electric Railway Economics."

"Central Station Practice," by Mr. James D. Ross, chief electrical engineer, Seattle Municipal Electric Light and Power System.

February 6th—"Choice of Apparatus and Material."

February 13th—"Switchboards."

February 20th—"Street Lighting."

February 27th—"Electric Station Records."

March 6th—"Load Curves and their Relations to Rates."

"Telephones," by Mr. C. E. Fleager, B. S. in E. E. (University of Illinois), superintendent inside plant, Sunset Telephone Company.

March 13th—"Modern Central Telephone Stations."

March 20th—"Maintenance Organizations."

March 27th—"The Telephone Engineer's Problems."

"Electric Power Transmission," by Mr. John Harisberger, general superintendent, Seattle-Tacoma Power Company.

April 17th—"Source of Power."

April 24th—"Prime Movers."

May 1st—"Apparatus for Generating Electric Power."

May 8th—"The Transmission Line."

May 15th—"The Receiving Stations and Distributing Lines."

These lectures are part of the regular courses given during the year on "Electric Railways," "Central Stations," "Telephones," and "Electric Power Transmission," and will be included in the field covered by the semester examinations.

While the lectures are primarily intended for members of classes in the above mentioned courses, the discussion of each topic will be sufficiently complete to be of value and interest to other students and particularly to the practical man in the electrical field. The treatment of each subject will be eminently from a practical point of view; the statements made and conclusions reached will be in accord with, and largely the result of, the lecturer's personal experiences.

Desiring to give the electrical men in Seattle, Tacoma and vicinity an opportunity to hear these lectures, the department of electrical engineering extends a cordial invitation to all men interested in the topics discussed to attend, whether or not they are connected with the University. The lectures are all free of charge, but prompt attendance is requested, so the work may proceed without interruption.

The next annual meeting of the Illuminating Engineering Society will be held on January 14, 1907, at which meeting there will be an election of officers to succeed those whose terms expire on that date.

The following officers are to be elected:

A President, to succeed Mr. L. B. Marks. (A retiring President is not eligible for immediate re-election.)

One Vice-President, the term of Dr. Clayton H. Sharp, expiring.

A Secretary, the term of Dr. A. H. Elliott expiring.

A Treasurer, the term of Mr. V. R. Lansingh expiring.

Two Managers, the terms of Messrs. F. N. Olcott and E. L. Elliott expiring.

The Decennial Founders' Day exercises of the Thomas S. Clarkson Memorial School of Technology at Potsdam, N. Y., will be held in Chapel Hall of that institution on the 30th of November.

WORLD'S FAIR AT SEATTLE IN 1909

Special Correspondence.

Seattle.—At the present time much interest is centered here in the work of creating the Alaska-Yukon-Pacific Exposition, which will be held in 1909, opening June 1st and closing October 15th.

Although three years remain before the fair will be opened to the public, the management is hard at work perfecting and carrying out plans to make the enterprise worthy of the purposes it will aim to accomplish.

Beginning with the idea of making the new Western world's fair original in every possible way, the management has succeeded admirably up to the present time, and if the financing of it, which broke all exposition records, can be taken as a criterion of the manner in which the plans already outlined will be carried out, there is no room for doubt as to the originality that will characterize the 1909 fair.

On October 2d last, five months after the incorporation of the exposition company, which was effected May 7th, the people of Seattle were called upon to finance the enterprise by subscribing in one day to its capital stock of $500,000. In a generous and public-spirited manner they oversubscribed to the extent of $150,000, making the total amount available with which to begin work $650,000. No other city for any purpose ever equaled such a feat. "Seattle spirit," for which the people of the Queen City are noted, was responsible for this remarkable achievement. More than a half a million of dollars in one day is a large amount of money to be raised in a city of 200,000 inhabitants. The slogan adopted by Will H. Parry, chairman of the Ways and Means Committee, was, "Everybody Helps," and everybody did help, with the result that an average of more than $3 was subscribed for every man, woman and child in the city.

As soon as the capital stock had been subscribed, John C. Olmsted, the noted landscape artist of Brookline, Mass., who laid out the Chicago and Portland expositions, was called to Seattle, and he is now busily engaged in designing the grounds and arranging the buildings. He has pronounced the site as, scenically, the finest ever utilized for such a purpose.

Henry E. Reed, director of the exploitation, is now busily engaged in making arrangements for the states to participate. He has Major T. S. Clarkson, special commissioner, in the field visiting the Governors of all the commonwealths. So far Major Clarkson has met with unprecedented success. Every Governor he has talked with has signified his intention of recommending liberal appropriation for a building and an exhibit. Mr. Reed is also carrying on an extensive campaign to secure the 1909 meetings of national conventions.

The executive committee of the exposition has appropriated $100,000 for the live stock show, which will be on an extensive scale, and from present indications promises to be the most successful ever held.

The management is receiving letters from all over the country endorsing the object of the exposition and pledging support from different localities.

The primary purpose of the fair is to exploit the resources and potentialities of Alaska, Yukon and the Pacific Northwest, and to make known and foster the vast importance of the trade of the Pacific Ocean and of the countries bordering upon it. Different from other fairs, the Alaska-Yukon-Pacific Exposition will not celebrate any particular event. The awakening of the Pacific, the wonderful achievement in all lines of effort of the countries in and bordering thereon, and the important role the commerce of the great ocean plays in that of the world, are the most noteworthy things the fair will celebrate. It will be a great international exposition. Historical sentiment will not be depended upon to arouse interest and induce participation.

In the first place the fair will show the world, through its exhibits, that Alaska can produce other things besides snow and gold; it will give the general public a better conception of the resources, advantages and possibilities of the territory, and of its geographical and climatic conditions. The same is also true of Yukon.

The fair will increase the commerce of the Pacific by teaching the merchants and manufacturers of the Orient and Occident the needs of the people of their respective markets, and how to secure and hold the business. Oriental buyer and Occidental seller, as well as Occidental buyers and Oriental seller, will be brought closer together to their mutual advantage, through exhibits collected with that aim in view.

The exploitation of the Pacific Northwest—in fact, the entire Western country—will be, naturally, another important result that will be accomplished by the Alaska-Yukon-Pacific Exposition. The Lewis and Clark Fair and its attendant publicity placed this section prominently on the map. The interest that exposition created beyond the Rocky Mountains in this section will be stimulated and increased during the next three years. With the foundation in exploitation laid by Portland to build upon, the attendance at the 1909 fair and subsequent benefits to follow will be on a large scale.

It is estimated that the fair will cost $10,000,000. The amount the exposition company will spend and the United States Government and State of Washington appropriations will make a fourth of this amount, and the sums the states, foreign nations, exhibitors and concessionairs will expend will aggregate the remaining three-fourths.

The exposition site comprises 255 acres of the campus of the Washington University. In its virgin state it presents everything to please the eye. There are tall, stately giants of the forest forming beautiful vistas, gentle slopes, commanding terraces and unsurpassed stretches of water front.

The grounds border for more than a mile and a half on Lake Union and Lake Washington. The Olympic and Cascade Mountains are in plain sight, and an unobstructed view of the perpetual snow peaks of Mt. Rainier and Mt. Baker may be obtained. In constructing the buildings and laying out the grounds every care will be taken to preserve Nature's own handiwork.

Different from former fairs, the Alaska-Yukon-Pacific Exposition includes in its plan the erection of permanent buildings. Many of the large exhibit palaces will be substantially erected, and they will remain as the property of the University after the fair closes, to be used for educational purposes. Thus the Washington State appropriation will be used for a permanent good aside from the benefits that will accrue to the commonwealth from the fair. The states and nations will be invited to erect buildings of a permanent character, which will give them an opportunity to install lasting memorials of their progressiveness.

DIFFUSERS FOR ARC LAMPS

Several prominent British electrical manufacturing companies now make diffusing and reflecting devices for use with the arc lamp by which harsh shadows and glare are practically eliminated and results equal if not superior to daylight obtained. The concentric light diffuser, which consists of a large round disc of corrugated metal fixed to the top of the lamp for reflecting the light downwards at a wide angle, is perhaps the most effective. This device also obscures the "wandering of the arc," the effect of which is very harmful to the eyesight. It is strange that the mercury vapor lamp has not gained more ground in British workshops and factories. The diffusive quality of the light of this illuminant is almost perfect, although its color is not all that could be desired, and its economy is exceptional. Possibly its backwardness may be due to lack of proper exploitation. Now that a company has been formed to deal specially with this lamp we may expect to hear more about it.—The London Engineering Times.

INDUSTRIAL

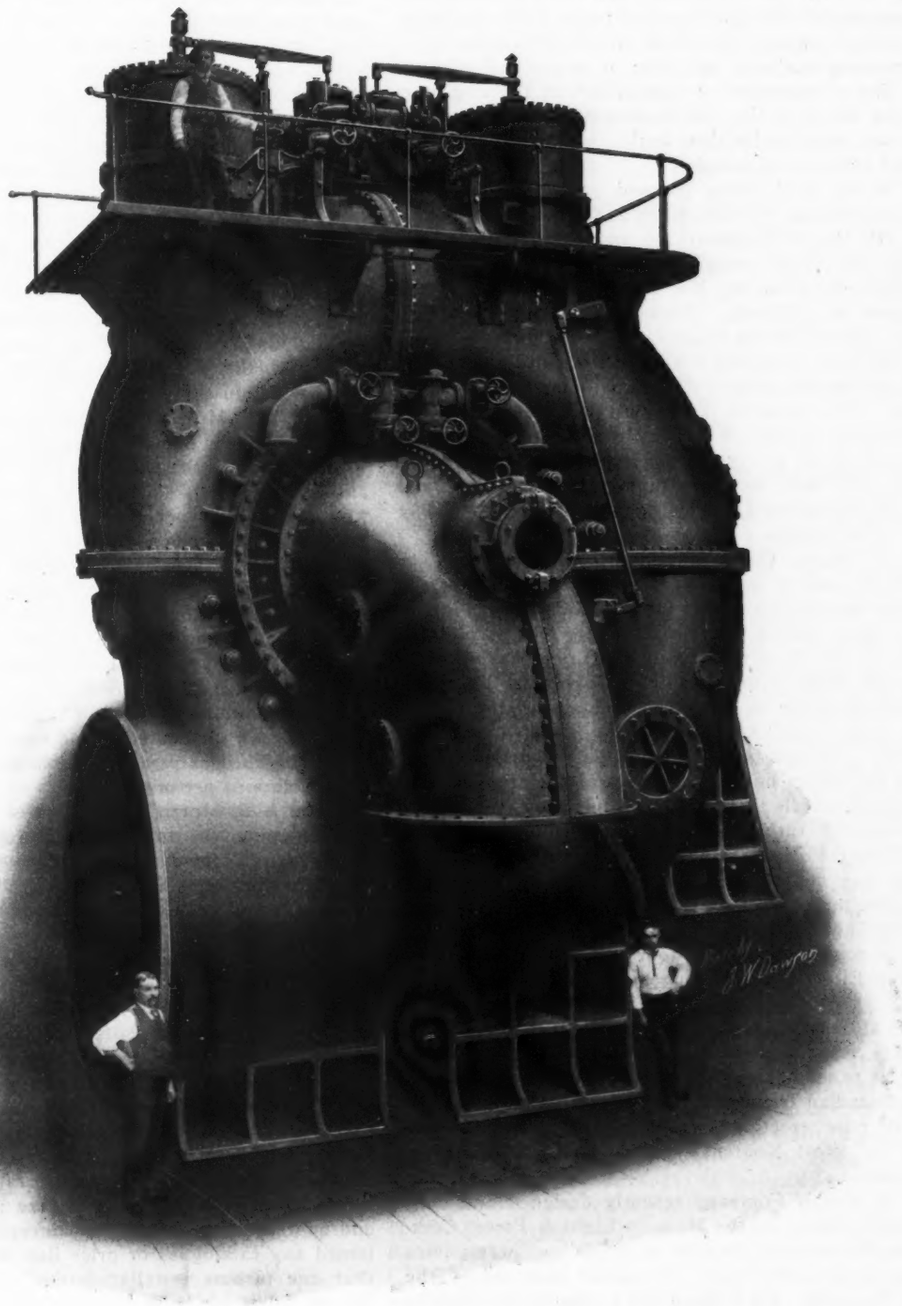
I. P. MORRIS COMPANY HYDRAULIC DEPARTMENT.

The I. P. Morris Company is another name for the hydraulic department of the William Cramp Sons & Engine Building Company of Philadelphia.

The I. P. Morris Company was organized in 1828, and incorporated under its present name in 1841, and was operated as an independent company until 1891, when it passed into the control of the Cramp Company. The Cramp Company was anxious to obtain the foundry facilities of the Morris Company. The works of the I. P. Morris Company are located adjoining those of the Cramp Company. Up until the Cramp Company obtained control of the Morris Company all their castings were made in the Morris foundry.

The hydraulic department of the Morris Company was created in August of 1904. It was established to meet the demands for designs of trubines and centrifugal pumps.

The force of the hydraulic department consists of about twenty-four designers and office men. It is the policy of the head of the department to employ college men and to train them to the methods adopted by the company for working out the various details of the design. German draughtsmen



familiar with the class of work have been employed at various times, but the American college man, when given proper training, has given better satisfaction than any other class of men. There are men employed in the department from the universities of Toronto, Cornell, Pennsylvania. Tulane and Pennsylvania State College, and several others.

A visit paid their works at Port Richmond, Philadelphia, by our representative was full of interest. The I. P. Morris Company, together with the mechanical, engineering and shipbuilding departments of the Cramp business, form one of the largest institutions in the world. Some eight thousand men are regularly employed, many of whom have been with them for a lifetime. Some were pointed out who had served sixty or seventy years.

The I. P. Morris Company is manufacturing a new governor, patented by Messrs. Glocker and White, both of whom are connected with the company, Mr. Glocker being the superintendent of shops and Mr. White the head of the hydraulic department. Four of the governors mentioned are being installed with the two 8,000 horsepower and two excited turbine wheels being furnished by the company to the West Kootenay Power & Light Company, Rossland, British Columbia.

The company makes a specialty of heavy and intricate castings. The concurrence of opinion of all the engineers who visit the works is that the casting are among the best that have ever come under their notice, both from the point of finish and evenness of metal.

Some of the work being planned or under present or recent construction may be described as follows:

The I. P. Morris Company are making preliminary designs for Messrs. Viele, Cooper & Blackwell for 18,000 horsepower turbine units for the Big Bend power plant on the Feather River in California. These wheels will run at 400 revolutions, and will be the largest powered wheels ever constructed. The first operating head will be 460 feet, but after the dam is increased in height the normal operating head will be 525 feet. The ultimate installation will be eight units, which represents a total of practically 150,000 horsepower. The total cost of the power installation will be from $3,000,000 to $5,000,000, which include a tunnel 15,500 feet long, and pipe lines approximating 1,000 feet in length, with a spillway at the end of the tunnel.

The I. P. Morris Company is now under contract to furnish and are now at work on the final drawings for the 13,500 horsepower turbine wheels for the McCall Ferry Power Company. These wheels will run at ninety-four revolutions per minute, and will be of the vertical shaft type, having three runners on one shaft, with movable guide vanes. The shaft will be about 20 inches in diameter. The size of the runner will be the largest ever attempted, being 8 feet 6 inches at the tips of the vanes and 11 feet extreme outside diameter.

Among the orders now in the shops of the Morris Company for turbine wheels there are now under construction six 10,000 horsepower turbine wheels for the Niagara Falls Hydraulic Power & Manufacturing Company, Niagara Falls, New York; five 6625 horsepower turbine wheels for the Northern Aluminum Company, Shawnigan Falls, P. Q., Canada; four 750 horsepower turbine wheels for Porto Rico. They have in course of erection four 13,000 horsepower turbines for the Electrical Development Company of Ontario, Limited.

The I. P. Morris Company built all of the turbine wheels in wheelpits Nos. 1 and 2 of the Niagara Falls Power Company and two of the 10,000 horsepower turbine wheels in the wheelpits of the Canadian Niagara Power Company. The Morris Company is now erecting two 8000 horsepower turbine wheels for the West Kootenay Power & Light Company, British Columbia.

The I. P. Morris Company recently designed and built two centrifugal pumps for the Mexican Light & Power Company for installation near the City of Mexico. These pumps were of the vertical shaft type, the motor mounted on the floor above the pump. Each pump has a capacity of 5,000,000 gallons per day of twenty-four hours when working under a head of 100 feet. The pumps were completed and shipped to Schenectady and there tested by means of a large weir box and weir, constructed outside of one of the main buildings. Various runners and styles of casing were tried on this test, with efficiencies ranging from 72 per cent to 80 per cent in the pump alone.

The runner and casing finally selected and built for the pumps gave an efficiency of 80 per cent when pumping against a head of 100 feet, single impeller, and when delivering 9½ cubic feet per second. The efficiency when delivering eight cubic feet per second was 78 per cent at a head of 105 feet. The efficiency when delivering six cubic feet per second was 70 per cent against a head of 108 feet, the pump running at 1000 revolutions per minute.

The I. P. Morris Company recently designed and installed in the city of New Orleans, for the drainage of the city, a centrifugal pump which delivers 320 cubic feet of water per second when working against a head of ten feet, as measured from the level of the water in the custion basin to the level of the water in the discharge basin, with an efficiency of 77 per cent. This pump was tested by the engineers of the drainage board of the city of New Orleans. It is a vertical submerged centrifugal pump, and runs at 62½ revolutions per minute, being driven by a 450 horsepower synchronous motor. The efficiency of 77 per cent included the losses in the piping from the suction to the discharge basins.

The I. P. Morris Company has recently secured an order for a four-stage turbine pump for the Sao Paulo Tramway, Light & Power Company, near the City of Mexico. This pump is to have a capacity of ten cubic feet per second against a head of 500 feet, when running at a speed of 380 revolutions per minute, and an efficiency of 78 per cent is expected of the pump. This pump will be completed and shipped within three weeks.

The I. P. Morris Company has just received the contract for replacing the pump of another manufacturer at the waterworks station of the city of Schenectady. This pump is guaranteed to have an efficiency of 76 per cent when delivering 7,000,000 gallons per day of twenty-four hours, against a head of 240 feet, when running at a speed of 1160 revolutions per minute. A penalty of $500 per day for each and every per cent by which the pump falls below 76 per cent is fixed. A like bonus is provided for in case the efficiency goes above 76 per cent.

The I. P. Morris Company is now building eleven pumps for the Mexican Light & Power Company to work under various conditions of head. Three of these pumps are of the high pressure turbine type, and each work against a head of 190 feet. The pumps are made single stage, and each run at 750 revolutions per minute.

The I. P. Morris Company has just completed and are now shipping one 10,500 horsepower turbine wheel for the Shawnigan Water & Power Company, an exact duplicate of one furnished on a former order. The first turbine, under careful test, gave 11,500 horsepower maximum, when operating under a head of 135 feet and running at a speed of 180 revolutions per minute. The maximum efficiency obtained was 87.3 per cent, at about 9750 horsepower. The efficiency at part loads was extremely high. The test was carefully made by the engineers of the Shawnigan Water & Power Company, and that company paid a large bonus above the contract price for the extra efficiency.

The company does not employ any agents on the Pacific Coast because of the specialty of their work. Turbine installations are most always special, requiring special attention. The company follows the practice of sending representatives direct from its home office to take up questions of designs and quotations on turbine machinery. The company has not issued any catalogues or price lists because it is rarely ever that one turbine installation fits into another. The I. P. Morris Company issue bulletins covering the class of work they have done, giving descriptions of the turbine wheels, and they also issue at times technical bulletins giving such technical information as consulting hydraulic engineers usually find valuable in getting up the design of power plants and also in studying the operation of turbine wheels. These will always be sent free to any of the readers who should write for the same, mentioning The Journal.

DIESEL ENGINES FOR INTERURBAN R. R. SERVICE.

The statement that high tension transmission for electric railroad service is made necessary, because of the necessity of installing a steam plant in a few large units centrally located will probably not be questioned.

In other words, if a steam plant could be subdivided into a number of small units, located at intervals in independent stations within the limit of low tension direct current transmission, the transformer station would probably be discarded and low tension direct current substituted.

This, however, is impossible with steam units without sacrificing operating economy, and if a low tension system is adopted for long distance operation it must be by installing some internal combustion engine having high fuel economy in small units without a corresponding increase in cost of operating labor.

It does not require any argument to convince the operator of electric railroad properties of the greater simplicity and reliability of the direct current system as compared with any method of alternating current transmission.

The adoption of the alternating current system (either single phase or with rotaries) as stated above, was necessary because of the difficulty and expense of transmitting a current of large volume and low tension over long distance from a central generating plant, **and is never sed where transmission distance is within the economical limits of a direct current system.**

The records of the Diesol oil engine in this country and abroad have demonstrated:

1st. The consumption of fuel per brake horsepower in the smallest engine is not 15 per cent greater than that of the largest units, and in every case is within the builders' guarantee of 12½ gallons of oil for each 100 kilowatt hours delivered in the switchboard under the operating conditions of the system as proposed in this article. **The actual fuel consumption of a 225-brake horsepower unit at full speed being 10¼ gallons for each 100 kilowatt hours at 90 per cent efficiency of the generator.**

2nd. **That the consumption of fuel per brake horsepower is practically constant from (½) one-half load rated capacity of the engine.**

With the above facts established as they have been by the records of many plants in actual operation, there should be no objection to the installation of Diesel oil engines for the work in so far as relates to fuel economy. It is also safe to assume that **the actual labor required to operate a number of Diesel primary stations will be less than that required for a central steam station together with that needed for the necessary transformer stations.**

The only objections to be raised would refer to the continuity of service, the extreme variation in the load, and small overload capacity of the internal combustion engines, but the installations of a small storage battery in each station successfully meets all of these objections and the desirability of the installation of Diesel engines and low tension direct current as a substitute for steam equipemnt and high tension current, either with transformers or single phase motors, becomes merely a question of first cost and future operating economy, and the following is offered as a close estimate of the comparative cost for installation and operation of a 50-mile road, with 50-ton cars operating at 30 miles an hour on one headway for 18 hours.

Diesel Engines with Direct Current Low Tension Transmission.

Length of road, 50 miles.
Maximum speeded cars, 30 miles per hour.
Number of cars, 5.
Weight of cars, 50 tons.
Average kilowatt per car, 100 kilowatt (70 watts per ton mile on low tension bus bars).
Number of power stations, 4.
Equipment of each station, one 150-kilowatt direct current, 650-volt unit; one 240-ampere hour battery.

Four engines deliver a total of 600 kilowatts per hour, and 16 hours of actual operation at full load would be sufficient for engine service, making a total output of 9,600 kilowatt hours per day.

The storage batteries would operate the road for the balance of the day, including owl cars and light and power for car barns when engines were idle.

One 240-ampere hour battery per station would be absolutely safe for the purpose.

Total fuel oil required—96x12½, 1,200 gals. at 3 cents, $36.00 cost.

The labor required for operating four stations would be as follows, divided into two shifts of 10 hours each:

One chief engineer and electrician, $5.00 per day.
Eight assitant engineers at $3.00 per day, $24.00.
Total labor per day, $29.00.
Supplies (lubrication and waste), $1.50 per day each station, or for four stations, $6.00 per day.

Operating Expense.

Fuel	$36.00
Labor	29.00
Supplies, Engine	6.00
Total	$71.00

Cost per kilowatt hour (fuel, labor and supplies), $71.00 —7.4 mills, 9,600.

RAILS MADE IN TWO PIECES.

Consul Hamm, of Hull, sends the following description of a demonstration given in Leeds, England, of a simple yet very useful invention connected with the tramway track: The present method of making tram rails is to make them in one-piece lengths. It is only the upper surface which receives any wear, and when this is worn out the whole rail and concrete bed have to be torn up and a totally new equipment put down. The invention separates the wearing surface from the permanent girdle support. It allows of the renewal of the wearing surface when necessary without pulling up the whole of the roadway or interfering at all with the under girder, which is tied down to the concrete bed. Under this system the renewing of tram rails apparently becomes as easy as resoling a worn pair of boots.

The invention is not in the rails, but in the machine requisite for combining two sections effectively. One locomotive carries the three machines that are necessary, one machine for rolling on the upper rail and two for cutting it off when it is worn out. The wearing portion of the rail fits down over the lower portion, the rolling on machine bending the depending flanges inward so as to grip the supporting rail. These depending angles are converted into cold rolled springs, with an inward grip so intense that at a test made by the Sheffield Test Works the adhesion of the top section to the bottom section in a length of only one foot was found to be twenty-three tons. The cutting machine cuts a groove into one of the depending flanges of the rails to a depth of one-third or half the thickness of the metal, while the breaking off machine applied to the two angles breaks off the partly cut flange, thereby releasing the head rail. These operations do not in any way injure or distrub the under T section.

If each time a renewal of the rail is necessary the cost of taking up the whole of the track is avoided, there must be a great saving, and the general manager of the Leeds tramways estimates this economy at 53 1-3 per cent. Another great advantage claimed for the system is that the work of renewal can be done very speedily at night, and involves so small an amount of material on the road that the traffic is very little interfered with.—From The Electric City.

ELECTRICITY AS A POWER IN MINING IN MEXICO.

Remarkable Change Brought About in the Last Year in Mexican Mining Camps.

When we come to consider the present mining industry with that of two or three years ago, or even taking it but one year ago, a wonderful change has taken place which is only apparent to those who are located in the immediate camp or camps using the new electric power. While it is true that the majority of the mines are still steaf or hand power, in some of our well known camps the excessive cost of power on account of the difficulty of obtaining fuel at a reasonable price, has brought the owners to look for a cheap power. This was absolutely necessary where the ore mined was not of extremely high grade.

This demand for cheap power has been solved by some few, few as compared with the many who are still left to avail themselves of it, in the adoption of electricity. True, this is cheapest when a water power is owned or can be obtained reasonably near at hand; nevertheless, there are many other means of generating electricity with great economy. One of these methods is by the gas engine, now rapidly being introduced into the republic. The gas engine of the present day though not as simple to operate as a single engine, has greatly improved over those of former years.

In El Oro and Guanajuato alone the Westinghouse Electric & Mfg. Co., through their agents, Messrs. G. & O. Braniff & Co., who are making this a specialty, have installed over 10,000 horsepower of electrical machinery, all of which is driven from a water power source. The cost of this power is from two to three times cheaper than the corresponding power by use of wood or coal, without taking into account the greater convenience, saving of time, increase in output, etc. Practically all of the mining machinery builders have for some time acknowledged electricity as the coming power, and have so modified their machines that they can be applied to electric motor drive or have gotten out a new line entirely for this purpose. In mines where steam has formerly been employed, electric motors can be applied to them if they are not too antiquated. Many have held back from the idea of putting in electricity, believing that nearly an entire new outfit of machinery would have to be purchased. This is a mistake, as steam hoists, compressors, and the majority of the machinery about the usual mill and mine can with very little expense be adapted to motor drive.

While in El Oro considerable activity. has existed for many years, so that the change to electric power has not been as noticeable; in Guanajuato the conditions have been quite differetn. In the latter camp a time was reached when the advancing cost of the necessary fuel made it impossible to profitably mine and mill the grades of ore obtainable For this same reason development work had to be abandoned to a certain extent. When we compare the present Guanajuato with the above conditions which existed but about two or three years ago, all of which has been brought about by the introduction of electric power, the possibilities obtainable where this force can be applied seem unlimited.

This has been referred to as the electrical age, and we find Mexico following very close to other countries in the introduction of this comparatively new power.

In Sinaloa, at the Black Mountain Mining Company, where electricity is employed entirely, we find it is generated by means of Westinghouse steam turbines at an expense greatly below that obtainable from the usual steam engine. With installations for generating electricity, the generating stations can be located at a considerable distance from where it is to be consumed, in some wooded sections if available, from which place the enrgy is cheaply transmitted, gas or steam being generated from the wood. This is what we find in Parral, where just such a plant is now going in to transmit to the mines about that place.

Another one of our most prominent camps which should be mentioned as being one of the first to adopt electric power and make use of it most universally is Pachuca A large amount of electrically driven mining and milling machinery has been, and is still being added to the various mines in this locality. The power in this camp is supplied by the Irrigadora Company. Until recently their large power plant at Juando was ample to supply the demand, but they are now building a second plant equally as large which will very srortly be in full operation. This company own sufficient water power to build even a third plant of about the same capacity, and due to the business in sight, this also may soon be developed to meet the popular demand for electrical energy.

In Oaxaca we find that within the last six months or a year a few of the companies in that district have ordered and will shortly have in operation isolated individual electrical plants for lighting and power in connection with their mining work.

The introduction of electric power to mining, milling and smelter work has long since demonstrated that it is no experiment, and that it has come to stay as a power, and our most economical one in this republic. Those who have once used electric motors have only the highest recommendation for them, and would by no means consider the thought of returning to steam. Those in the republic who are finding the fuel question a problem and are trying to figure out how to mine or mill cheaper in order to make use economically of low grade ore and show a profit, would do well to consult with those in the country who are doing this very thing, having found it possible by the use of electricity.

Aside from the acknowledged economies found in electric motor drive, the great conveniences which result in increased output to mine and mill should be given due consideration by those contemplating electrifying. These are more apparent to those who have used both steam and electricity. A few of them are readily seen when we compare a modern electric mine locomotive with man or mule power for handling ore cars in the mine or between mine and mill if they are separated by some distance. Compare also the piping of steam with the running of wires about a plant, and take into consideration the loss, as usual unappreciated, due to condensation of the steam in such pipes. Also consider the convenience of having the motor located immediately at the spot where the power is desired, as with a ventilator or blower in the mine, the better service resulting from good lighting, etc., etc. These are but a few of what might be mentioned in this connection, but are sufficient to indicate what is referred to.

We are all interested in making the best possible extraction from ores at the least possible expense in order to accomplish which we should give careful consideration and study to the most modern methods, that our properties may give us the best returns for the money expended, at the same time not begrudging too much a first cost that will pay for itself in a few months out of the savings.

PROTECTING IRON.

The protection of iron by coating with zinc has become so important an industry that one-half of the total zinc production of the United States is used for the purpose; the total amount of zinc produced in that country in the year 1904 was 181,000 tons. Zinc is electro-positive to iron, and in the presence of moisture forms a galvanic couple, the zinc dissolving and the iron remaining intact; it is, therefore, considered by engineers to be the best protective metallic coating for iron, and the most economical and durable of all methods for the prevention of corrosion, and zinc coatings would be still more extensively used if it could be applied to such structures as bridges and roof principals.—From London El. Engineer.

NOVELTIES IN TELEPHONE INSTRUMENTS.

A firm whose specialty is electrical apparatus has within a few weeks, says the "New York Commercial," set before the trade three new types of interior telephone instruments. They are built along lines similar to other standard instruments, and yet are distinctly new in the combination of the different parts which enter into their make-up.

One of the three is a single-point circular flush wall telephone designed for use in location where space is somewhat limited and where an instrument that protrudes from the wall would not be desirable. The working parts are inclosed in a metal case six inches in diameter which sets into the wall, allowing the face of the instrument to rest flush with the wall surface. The transmitter is of the solid back, granular carbon type, mounted on an adjustable bracket, so that it may be used by persons of different heights.

The receiver is of the standard bi-polar, inclosed terminal type, mounted in a hard-rubber shell. The face of the instrument may be finished in any one of a variety of woods which is best suited to the location where the instrument is to be installed. A flush push-button is mounted on the face, and if desired, a number of buttons may be added, so that the instrument can be used in connection with others of a similar nature, making a complete interior telephone system. These instruments can be used in connection with the automatic central, or may be used as branches of a telephone exchange.

The single-point school type of telephone is one of the latest instruments brought out. It will be found especially adapted for use in schools, hospitals and similar buildings. The equipment of the instrument is much the same as that of the flush telephone just described. A solid back, granular carbon transmitter is used, mounted on an adjustable bracket, and the receiver is of the bi-polar, inclosed terminal type, in hard-rubber shell.

Standard battery telephone bells are used and a flush push-button is provided for calling. A feature which has been added to this new instrument is that of a chain connecting the receiver cord to the switch hook, so that if the receiver is accidentally left hanging, the contracts are closed and the instrument is connected into circuit.

Instruments of this type can be used with good efficiency in connection with an automatic central, or with a telephone annunciator. They may also be used in pairs if desired. The standard finish of these instruments is quartered oak, but they may be made to match the surroundings where they are to be installed.

In the hand microtelephone there is a unique combination of a bi-polar, watch-case receiver and a granular carbon transmitter. The construction is such that when the receiver is held to the ear, the mouthpiece of the transmitter is in proper position for speaking. The handle, which is of hard rubber, contains a push-button which throws the batteries in or out of circuit at the will of the operator, thus prolonging the life of the batteries, as they are automatically cut out when the set is not in use.

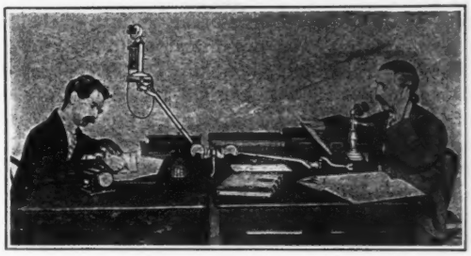
The instrument may be readily taken apart for inspection or adjustment. It is provided with a ring so that it may be hung up out of the way, and it is especially adapted for use as a desk instrument in connection with a local telephone exchange or as a branch instrument with the automatic central, and in fact in all capacities in which a portable instrument can be used. These instruments may be provided with a metallic mouthpiece for the transmitter, when used where they will receive hard usage.

ADVANCING MARKET IN ELECTRICAL APPARATUS AND SUPPLIES.

Prices in the electrical trade continue to show a distinct upward tendency in sympathy with the well maintained advance which has taken place in the prices of all raw materials. Orders for future delivery can only be placed in many instances at a considerable advance over present market quotations.

The General Electric Company, in common with many other large manufacturing concerns, is announcing a general advance in prices of electrical apparatus and supplies. This will not unlikely be followed by further advances if present market conditions continue.

Among the most useful devices in conection with daily life are the many various styles of telephone brackets, which are being manufactured and sold throughout the country. The old habit of using the old style wall telephone has ceased to exist, and the more up-to-date extension telephone, commonly called a "desk telephone," is today modern practice, as the average desk is usually covered with papers and other matter, which leaves no available space for the telephone. Therefore, the inventor has been called upon to provide this necessity, and his work has been successfully accomplished in the development of the Equipoise telephone arm, a cut of which is shown herewith.



Many improvements have been made since this bracket was first put upon the market, and today it is unquestionably one of the most desirable devices of its kind, for the reason that it can be used in any position at the desk, and can also be used by a person in a standing position, as is clearly shown in the above cut.

Since the recent disaster in San Francisco, which destroyed all such devices, it has been almost impossible for the manufacturer to supply the great demand for these brackets, particularly among the large corporations, who require as many as 200 to 300 in one equipment. The manufacturers of this bracket, through their various agents, make the practice of furnishing brackets on trial orders so that no one need feel the necessity of isvestment of any kind until they have had the opportunity of satisfying themselves of the merits of this device.

THREE THOUSAND HORSE POWER GAS ENGINES.

A steel-making company in Indiana has given the largest single order for gas engines probably ever placed by any one company. It is for eight gas engines of 3,000 horse-power each, capable of delivering 30,000 cubic feet of free air per minute to the furnaces which produce the blast-furnace gas, which, in its turn, is also used to operate the engines.

Dossert & Company of 242 and 244 West 41st street, New York, announce the receipt of advices from their representative in Italy, that the Dosert Solderless Connectors for wires and cables exhibited at the Universal Exhibition in Milan, 1906, have been awarded a gold medal.

Owing to their increasing business in the city and vicinity of Baltimore, hte H. W. Johns-Manville Co. have opened a branch office at No. 315 Equitable Building, Baltimore, Md. This office will be in charge of Mr. W. F. Baird, previosuly connected with the Philadelphia branch of the company.

News Notes

TELEPHONE AND TELEGRAPH.

Oakland, Cal.—F. S. Thompson, general chairman of system division No. 53, Order of Railroad Telegraphers, died suddenly at El Paso while on his way to the convention. Mr. Thompson was 40 years of age and had been in the railroad telegraph service for the Southern Pacific Company and other lines for twenty-five years, and for the past eight years had been closely identified with the organization of which he was elected general chairman about a year ago.

Oakland, Cal.—The annual meeting of the conference committee of the Pacific System Railway Telegraphers was held here this week in the Hotel Metropole, where the members of the committee are quartered.

Columbia, Nev.—Goldfields capital is strongly in evidence in the northern camps, Henry Weber having filed articles with the Secretary of State declaring his intention to construct a telegraph line from Fallon to Wonder. Work will begin at once.

Grass Valley, Cal.—The Forest Springs Telephone system is now assured. An organization, to be known as the Forest Springs Telephone Company, has been formed. When material arrives work will begin. It will require about 20 miles of wire to reach and connect with the Grass Valley line.

Fresno, Cal.—The management of the Sunset Telephone & Telegraph Company is about to increase largely the size of its office building. The building is now two stories high and onother story will be added. J. P. Noble, the division superintendent, announces that the enlargement of the building has been decided upon and the company will call for bids in a short time.

San Jose, Cal.—State Forester G. B. Hull has let the contract for building a telephone line from Boulder Creek to Governor's Camp in the Redwood Park, in the Big Basin. This will be completed within three months.

Ashland, Ore.—The work of building a new rural line from this place to Dead Indian country is under way by the contractors, Spence & Phillips.

Butte, Mont.—The Bell Tel. Co. has taken a permit for an exchange building to cost $60,000.

Bellingham, Wash.—The Laurel Sunset Co. has been organized at Laurel, and will build a telephone line to Bellingham. W. L. Chandler, president.

Bellingham, Wash.—The trustees of the Silver Lake Tel. Co. applied to commissioners for a franchise to build a line along the county roads.

Edmonton, Alba.—Johnson & Warren received the contract for the telephone building at $22,538. It will be 50x75 feet.

Wilson Creek, Wash.—The Wilson Creek Krupp Tel. Co. has been organized with Dr. H. Mitchell, president; J. W. Brewer, secretary.

POWER AND LIGHT PLANTS.

Georgetown, Wash.—Permits were issued by the city for the erection of five new fire proof buildings, covering 130,000 square feet of ground space, to cost $100,000. The buildings will be of reinforced concrete and are to be erected by Frank B. Gilbreth.

Palo Alto, Cal.—The City Trustees have received bids for the construction of a temporary wing at the city power plant to house the new machinery which was purchased by the city and which will arrive soon. The contract was awarded to E. A. Hettinger, whose bid was $2890. The contract called for a frame structure which will be used as a makeshift until the Trustees are in a position to construct a building of reinforced concrete.

Los Angeles, Cal.—The Board of Fire Commissioners has acted on the following applications: I. Edises, 254 North avenue, 20-horsepower electric motor in mattress factory; Carpenter and Biles Mill & Lumber Co., 3310 South Main street, additional electric power in planing mill; Sunset Iron Works, 1427 Kearney street, electric motor; M. A. & J. E. Swingley, 517 East Ninth street, electric motor in bakery; S. Tacsen, 1316 South Main street, electric motor for art metal factory; and Bierrend & Poplin, 1625 McCarry street, four electric motors for furniture factory.

Columbia, Nev.—Arrangements are being made to install an electric hoist on the Merchants' lease on the Miss Jessie claim of the Laguna group at an early date.

Grace, Ida.—The Telluride Power Co., of Salt Lake City, has decided to construct a power plant at this place; estimated cost, $1,000,000.

Granite, Ore.—The Fremont Power Co. is installing an electric power plant, power for which is generated from Olive Lake and Lost Creek. A power transmission line is being constructed from the power house to Bourne, a distance of twenty miles.

Hillyard, Wash.—A new electric compressor, twice the size of the one now used, is being installed in the railroad shops.

Missoula, Mont.—The Missoula Light and Water Co. has incorporated with $400,000 capital. A. H. Wethey, general manager.

Prince Albert, Sask.—The Board of Trade has selected Charles H. Mitchell of Niagara Falls, to investigate the power resources of the North Saskatchewan with a view to developing the same.

Spokane, Wash.—E. Wegner, manager of the Big Baldy Mining & Milling Co., states that his company will erect a power plant to develop 1,000 horsepower on Crooked Creek. The plant will cost $50,000.

Falls City, Ore.—The Council has granted the Northwestern Guarantee & Trust Co. a franchise to erect and maintain an electric power plant here.

Miles, Wash.—The Big Bend Traction Co., which has a force of men grading the electric line on the military reserve, is preparing to remove the camp to Crystal Springs, when they will continue work all winter.

New Westminster, B. C.—The B. C. Electric Ry. Co. will lay a double track on Columbia street.

Prosser, Wash.—The Prosser Traction Co. has been incorporated by Frederick Finn, J. W. Callicotte, G. A. Todd, George E. Boomer and T. A. Jenne. Capital, $150,000. The company is to build an electric railway through the city on an interurban line to the proposed North Coast railway station.

Portland, Ore.—The Portland Ry. Co. is considering the extension of its Woodstock branch.

Snohomish, Wash.—The Snohomish Valley Railroad Co. was granted a 50-year franchise through the city.

Spokane, Wash.—It is reported that Eslick & Hartnett have been awarded the contract for the construction of a line from Hayford to Cheney, a distance of ten miles, for $50,000.

Crown King, Ariz.—A number of parties interested in mining in this section are gathering data regarding the practicability of erecting a large steam power palnt for generating electricity to be used by the various mines.

El Centro, Cal.—C. F. Paris has been appointed general superintendent of the Holton Power Company and Holton Interurban Railway, vice C. A. Howell, resigned. The general offices of this company will be located at El Centro in the near future. The railroad will probably be extended west to the Blue Lake neighborhood.

Searchlight, Nev.—W. W. Hurt, W. F. Mitchell and M. W. Levy have left for Los Angeles. Messrs. Hurt and Mitchell will purchase electrical equipment for the Waterspout mine, which is owned by the Searchlight-New York Mining Company. The Waterspout is situated upon the townsite of Searchlight.

FINANCIAL.

Visalia, Cal.—An assessment of 5 cents per share has been levied on the capital stock of the T. C. Oil Company, payable immediately.

San Francisco, Cal.—In accordance with the terms of the bonds issued by the Presidio and Ferries Railroad Company, the directors of the company have determined by lot the numbers to be redeemed at the California Safe Deposit and Trust Company in the city of San Francisco, on the 15th day of December, A. D. 1906, with the following result: Nos. 21, 32, 33, 34, 35, 39, 51, 59, 81 and 101, which bonds will be paid on the 15th day of December, upon surrender, with coupons attached, and interest thereon will cease from and after that date.

San Jose, Cal.—In the suit of Charles Miller vs. the Bay Cities Water Company, involving the right to the waters of the Coyote River, on the west side of this valley, decided for plaintiff, the Superior Court has denied the motion of the defendant for a new trial.

San Francisco, Cal.—From the present rate of earnings it is estimated that the United Railroads will make just about sufficient during the calendar year ending December 31, 1906, to meet the full dividend payment on the preferred stock, after the usual fixed charges, depreciation and sinking fund appropriations. Officials of the company estimated, before the recent strike, that the gross earnings for the year would be $6,000,000. Up to August 26th the actual gross earnings were $3,861,000, leaving $2,139,000 to be earned during the remainder of the year, in order to bring the figures up to the estimate. Owing to the strike, which began on August 26th and tied up operations for eleven days, involving the company in a loss of revenue of about $180,000, it is not expected that this estimate of $6,000,000 will be fully reached As a matter of fact, the road is now running at an average rate of about $16,500 a day, and the daily earnings should gradually increase as new cars and lines are put into operation. This rate per day can, therefore, be conservatively taken as a minimum for the remainder of the year, which would mean gross earnings for that period of $1,930,000, bringing the total earnings of the year up to approximately $5,800,000, or $200,000 less than the estimate made by the company a couple of months ago.

INCORPORATIONS.

Groveland, Cal.—Articles of incorporation of the Great Western Power Company have been filed here. This company has been formed for the purpose of erecting an electric power pant for use in railroading, mining, sawmilling and in other purposes.

Pasadena, Cal.—The Pasadena, La Canada and Los Angeles Railway Company has been incorporated to build an electric railway to connect Pasadena and La Canada and ultimately to extend the road to Los Angeles. The incorporators include George E. Smith, C. E. Crewell and E. G. Thomson.

Richfield, Utah.—Articles of incorporation have been filed for the Richfield Electric Light and Power Company, of which Thomas Brown is president. With this start the company is ready to begin work of putting a plant at Glenwood to connect with this city. Ras Jenson has been awarded the contract for getting out the poles.

San Diego, Cal.—The Pacific Coast Development and Securities Company has been incorporated with capital of $1,000,000 for the development of this section. The operations of the company will include the erection of power plants, fuel plants to supply gas and electricity and the construction of transportation lines outside the city limits of an interurban character. Incorporators are John Campbell, Arthur Small, John K. Durrell and Frank Turnbull. A large amount of English capital is supposed to be behind them.

Tucson, Ariz.—The Nelson Liquid Fuel and Oil Burner Company has filed articles here. The incorporators are H. Frink, Max Pointer and F. E. Nelson and others. Capital, $200,000.

Vallejo, Cal.—The Vallejo and Northern Railway Company has been incorporated witha capital stock of $2,500,000, subscribed $75,000 by T. T. C. Gregory of Suisun, G. S. Lackie, C. F. Kinsey and J. C. Veitch of Oakland, $500 each; Melville Dozier of Oakland, $68,000. Place of business, Vallejo.

Sunnyvale, Cal.—Some of the leading citizens of this town have formed the Sunnyvale Water Company, with a capital stock of $100,000, one-quarter of which has been subscribed for. The officers of the company are: F. J. Fewings, president; J. H. Hendy, vice-president; J. McCullough, secretary; Bank of Sunnyvale, depository. The directors are: F. J. Fewings, J. H. Hendy, C. C. Spalding, F. J. Behneman and W. A. Crossman. Pipe worth $10,000 has been ordered and mains will be laid through the principal streets.

TRANSMISSION.

Salt Lake City, Utah.—Lucien L. Nunn of Provo, who is associated with the Telluride Power Company, has filed application for water rights. His plan contemplates the impounding in separate reservoirs of 10,560 acre-feet of water from Rock Creek, a tributary of the Duchesne River, in Wasatch County, for the development of 1600 feet of water which will drop from the head of 985 feet upon fifteen Pelton wheels, generating 150,000 horsepower of energy. From the twin reservoirs a system of ditches, flumes and piper will convey the water nine miles to its head of almost 1000 feet. It is estimated that the first of these reservoirs will store 5760 acre-feet of water and the second 4800 acre-feet. It will require three 10-foot pipes to convey the stream of water developed in these two reservoirs. After turning the wheels the water will run through a system of canal..

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Prescott, Ariz.—At a meeting of the Baumann Copper Company, to be held in Pittsburg, bids for the installation of the electric generating station on the Agua Fria River, the construction of a narrow gauge electric road and an aerial tram from the camp to the Humboldt smelter, as well as other machinery and materials, will be considered.

Chihuahua, Mex.—The Parral Power and Reduction Company proposes building hydro-electric plants on a tract of land over the Chauhuahua state line in Durango and transmitting power to operate reduction plants to be established in the Parral district.

Los Angeles, Cal.—The Fire Commissioners have granted a permit to W. Kahle to establish an electric motor in his shop at 1704 East Sixteenth street; L. D. Hellman, a permit to install a gasoline engine and electric motor in his furniture factory, 117 North avenue; to Crown Carriage Company, for an electric motor at 717 San Pedro street; to Western Door and Sash Company, electric motor at 1409 Mission road.

Los Angeles, Cal.—The Board of Trustees of Los Angeles High School district is receiving sealed bids for a 30 horsepower Westinghouse motor, on sliding base, 110 volts, shunt wound, direct current, with starting box, double pole switch, fuse block and pulley complete, speed about 900 revolutions per minute, to be placed in position in Polytechnic High School building under direction of Prof. Hood, head of mechanic art department, and Engineer J. E. Chick.

Santa Barbara, Cal.—An ordinance has been adopted by the Board of Supervisors of Santa Barbara County granting to the Merchants' Mutual Electric Light and Power Company a franchise to erect poles and wires for transmitting electricity for heat, light and power purposes along certain highways in the county.

Vallejo, Cal.—At the meeting of the Board of Education some extra electric appliances for the High School laboratory were ordered purchased by the board.

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City of Mexico, Mex.—The Compania Agricola y de Fuerza Electrica del Rio Conchos has been organized in Chihuahua to construct an immense dam near the city of Camargo to provide water for generating power for light, etc. The president of the company is Pablo Ginther; Juan A. Creel, treasurer, and Lic Joaquin Cortazar, secretary.

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Electric Manufacturing Co.
Fort Wayne Electric Works
General Electric Co.
Kilbourne & Clark Co.
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Standard Electrical Works
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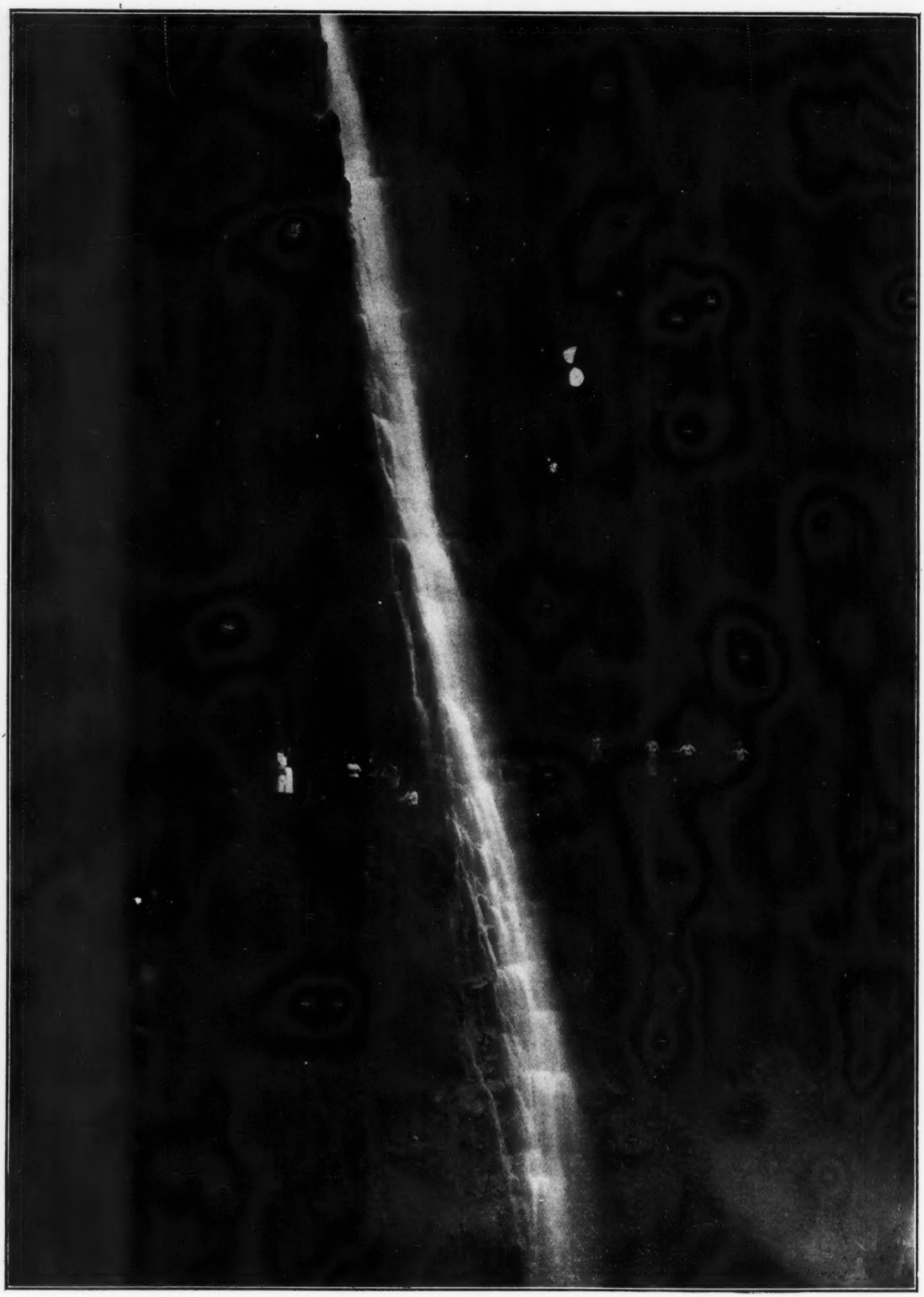
Byllesby & Co., H. M.
California Electrical Works
Cannon, Edward F.
Century Klein Company
Cole Co., John R.
Copeland, Clem A.
Cory, C. L.
Hunt, Dillman,Meredith&Allen
Doble Co., Abner
General Electric Co.



AQUEDUCT UNDER WATER-FALL.

Irrigation Works in the Hawaiian Islands